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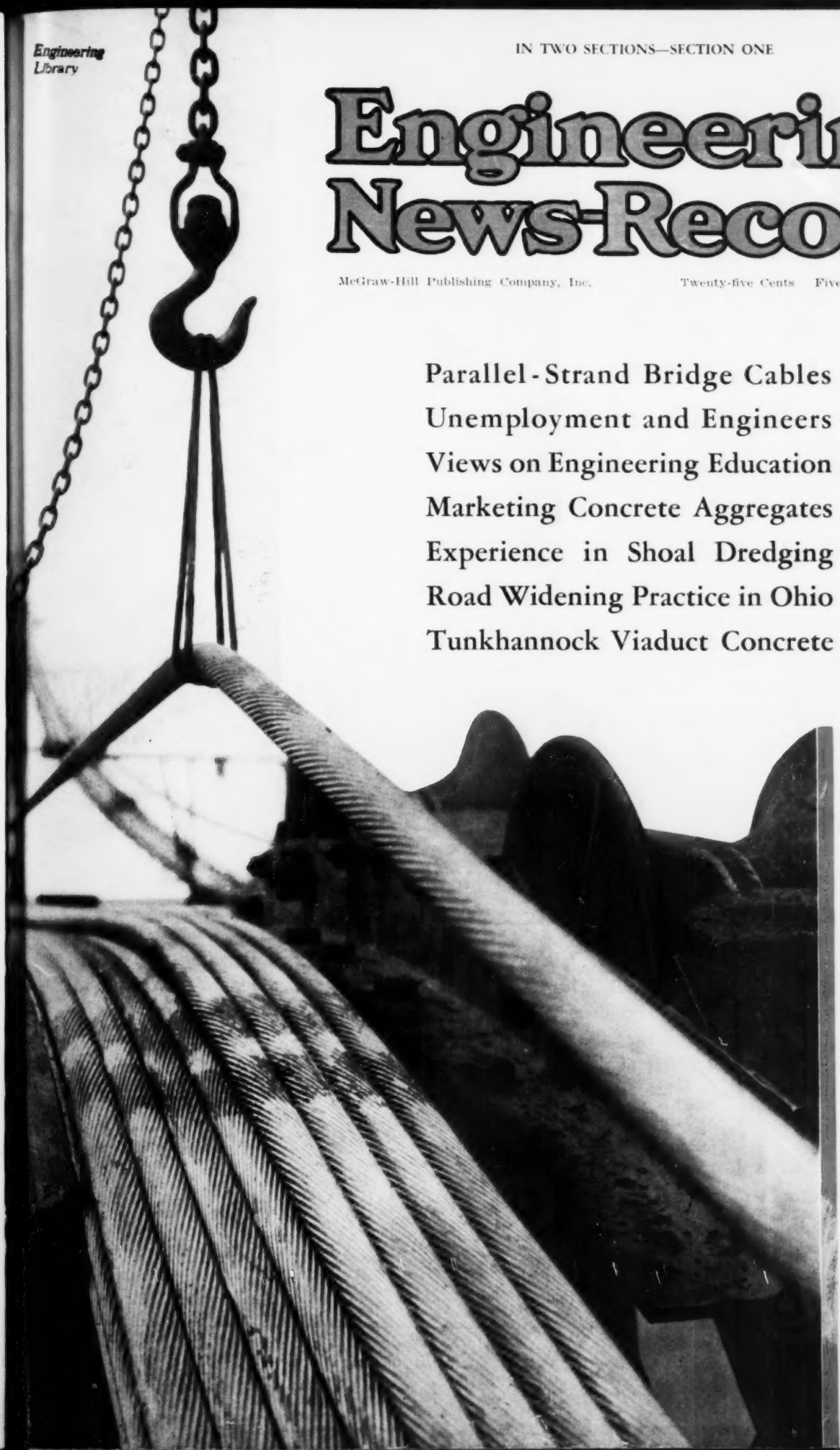

January 14
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Assembling a suspension bridge cable of prestressed shop-manufactured strands

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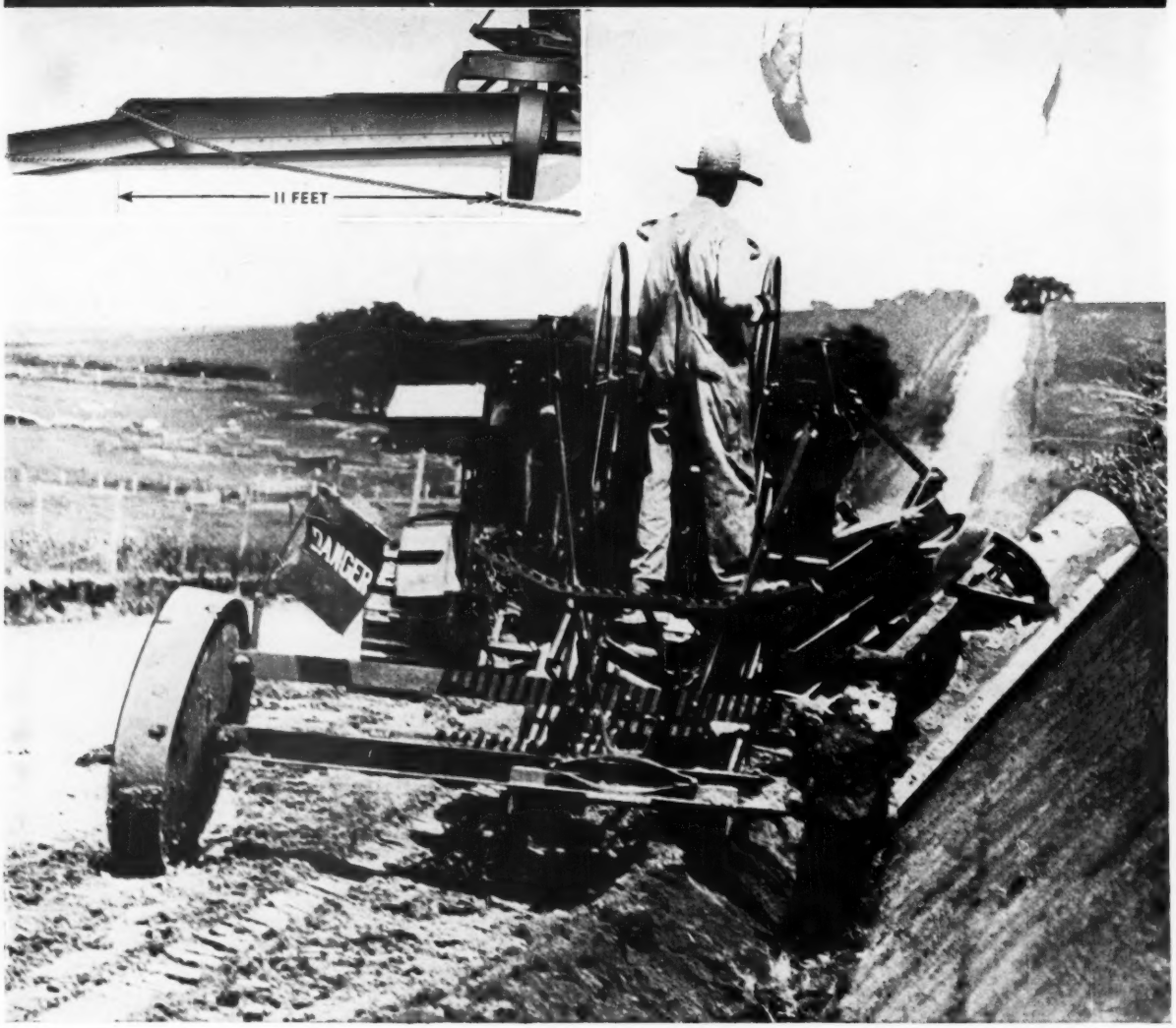

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F. E. Schmitt, Editor

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Engineers Go First

WHILE engineers on one hand are bending every effort to find jobs for the fellows out of work, mayors and city councils are discharging others in an effort to begin the New Year with reduced municipal budgets. Detroit has just made a drastic cut in municipal expenditures, and as is generally the case when municipal expenditures are cut all new construction has been eliminated. Maintenance work also is to be greatly reduced. In the city engineer's office half the force has been laid off. Similar reports come from other cities. It is a discouraging prospect not only because of the increase in unemployment among engineers but also because of its evidence that the axe has been used where it was easiest to make a showing regardless of the value of the services sacrificed in relation to other municipal expenditures.

Leading Articles

Parallel Strand Bridge Cables.....46
Experience in Shoal Dredging.....50
Pennsylvania's 152-Lb. Rail.....54
Road-Widening Practice in Ohio....55
Tunkhannock Viaduct Concrete 57
Marketing Concrete Aggregates 59
Engineering Education.....63
Unemployment and Engineers.....68

Research for the Unemployed

EDUCATION as a morale-builder for unemployed engineers, initiated by the decision of Columbia and Ohio State universities to permit the free attendance of this group at classes, has been carried one step further by Rutgers, which will appoint for the spring term six research assistants to be paid a modest stipend in addition to being exempted from tuition fees. In return, these men will devote part of their time to research in engineering. The idea is a happy one, inasmuch as it will be of benefit to all concerned. The university will gain by securing for its investigations technically trained minds with the practical viewpoint; the successful applicants will reap the double advantage of stopgap employment and of experience that is sure to be useful when conditions improve; and the engineering profession will receive additional fundamental data as a result of the studies to be prosecuted. With Rutgers pointing out how research funds can be spent to triple advantage, it is to be hoped that other educational institutions will adopt this excellent plan.

Sound Concrete

GOOD CONCRETE may be assured by the conscientious application of a few simple rules. This fact becomes increasingly evident as surveys are completed of concrete structures in service over a period of years. Those structures upon which these rules—largely matters of commonsense and not intricate formula—have not been violated show up exceedingly well. The famous Tunkhannock viaduct of the Lackawanna Railroad, the largest concrete railroad bridge in the world, has recently undergone a thorough inspection after seventeen years of service. Wind-blown water had caused some discoloration, and imperfect expansion facilities in the parapet resulted in some cracking, but otherwise the 165,000 cu.yd. of concrete in its ten 180-ft. spans is in perfect condition inside and out. Searching for some explanation of this sound condition, one finds only that the mix was not uncommonly rich (1:2:4 for the floor and 1:3:5 for the remainder), that the aggregates were clean and sound, that the mix was as dry as it could conveniently be placed, that thorough mixing was mandatory and that every placement was carefully rodded and tamped. Quite similar factors were held to account for the sound concrete in structures examined several years ago by a committee of the American Concrete Institute. Conversely, the poor quality of other concrete in most cases was attributed to violation of one or more of the above-mentioned simple rules. These inspections of structures in service are providing the concrete art with a much needed background. They should drive home the fact that, regardless of the refinements in strength and density to be obtained through the application of modern discoveries in aggregate proportioning and mix design, the production of durable concrete still rests on a few simple rules, conscientiously and sensibly applied.

Bridge Clearances

UNDER General Lytle Brown the attitude and practice of the War Department in respect to bridge clearances over navigable waters has undergone a change for the better. It is a pleasure to record this belief, for the opinions expressed in these columns heretofore on this subject have often had to be sharply critical. There are still many reforms that seem necessary and desirable, but the continuance of the current program to fix minimum clearances on major waterways seems to point the way to distinct improvement. For instance, as a result of hearings that have been held in various Mississippi River cities minimum horizontal and vertical clearances have been announced for the river from Cairo to New Orleans. No longer will it be necessary for the bridge designer to grope in the dark regarding the height and span that will be required of his structure, for if it is between Cairo and Vicksburg he must provide a vertical clearance of 55 ft.; if at New Orleans the clearance must be 133 ft. When this rationalization process has been extended to all navigable streams, including such coastal waterways as the Hudson and

Delaware rivers in the East and the Columbia River and the tidal waters around San Francisco in the West, a long step forward will have been made; land transportation interests should be able to plan their structures with more ease and economy and the War Department should be relieved of much routine work that must be distasteful as well as time consuming and expensive. It is too much to hope that all minimum clearances set will be satisfactory to all concerned or that they will prove after trial to be perfectly equitable. But regardless of what clearances are set, the important fact is that definite values are being fixed as a result of the first real attempt to weigh and allocate the rights of land as well as water transportation. That in itself constitutes progress.

A Check to Bid Shopping

ONCE again action is threatened from the outside to clean up a situation within the construction industry that should be taken care of by the industry itself. Representative Goss, of Connecticut, has proposed measures to remedy the pernicious bid-shopping practice. He would have general contractors on public works submit with their bids a list of subcontractors and material-supply men he intends to employ in the fulfillment of the contract. The successful bidder would be required to use this list in carrying on the work, thereby, theoretically at least, stopping bid shopping at its source. Undoubtedly, if the plan could be made to work, it would clear up to some extent a distressing situation which is adding materially to the present chaotic state of contracting. However, at its best it would be but a partial remedy. Bid shopping is not practiced by general contractors alone but starts at the top with the architect and goes on down through general contractors and subcontractors and to the material and equipment supply men. Spiking one of the heavy guns might slow up the war, but complete peace will never come until that peace is wanted more sincerely by all who have a hand in a construction operation. It is up to the construction industry as a whole to clean its own house before outside action forces undesirable regulation upon it.

Deeper Rails

BY INCREASING the depth of its heaviest rail to 8 in. the Pennsylvania Railroad has paved the way for an actual test of the claim that many of our present-day troubles with railroad track will be eliminated by the use of stiffer rails. The Pennsylvania's new rail weighs 152 lb. per yard. Several miles of it were put into service during the latter part of last year. Previous to that time the company's heaviest rail weighed 130 lb. and stood $6\frac{5}{8}$ in. high. That rail has been redesigned to increase its height to $7\frac{1}{8}$ in., but only one pound has been added to the weight per yard. Its new design adds considerably to its stiffness at no material increase in cost. Intensive research into track stresses in recent years has pointed to the need for greater rail stiffness, not only for a more uniform distribution of wheel loads to the roadbed but to reduce the strains put upon the metal in the rail itself. Many students of track troubles hold that the rapid development of the transverse fissure—the greatest single source of rail failures—was due to the high stresses to which rails are subjected under modern conditions. Others hold that transverse fissure development is independent of rail stress conditions. The new Pennsylvania sections should help to clear up this point, especially with respect to the redesigned 130-lb. rail. A study of track stresses under the new rails also will serve to demonstrate the accuracy of predictions of other gains to be obtained by increasing rail stiffness.

Wanted—A Name

A STRUCTURAL part without a name is a fair characteristic of the recently developed suspension bridge cable that is assembled from prestressed shop-manufactured strands. Paradoxically this type of cable is without a name because it has, in its short life, acquired too many names. Among the appellations applied to it have been rope-strand, bridge-strand, parallel-strand, twisted-strand and twisted-wire strand cable. Which name is best has been the subject of some debate. Obviously rope-strand is incorrect, for ropes have a center core of hemp or metal and are in reality made up of a group of twisted strands. Bridge-strand is not incorrect but is far from being accurately descriptive. Twisted-strand is misleading, for the strands are not twisted. When we come to parallel-strand and twisted-wire strand, the choice becomes more difficult. Against the use of parallel-strand, there is the fact that parallel-wire cables, strung in the air, are made up of parallel strands. In the article in this issue on the Maysville bridge, the term parallel-strand cable is used, since it is preferred by the manufacturer and contractor on this structure. On another page two engineers eminently qualified to discuss the subject present their different views. The fact that their views are different is significant of the situation. The cables in the Grand' Mere bridge in Quebec, the Maysville bridge in Kentucky, the Waldo-Hancock bridge in Maine and the St. Johns bridge in Portland, Ore., still are without a name that describes them accurately and at the same time is generally accepted.

Proof in Use

THEORY is sometimes disproved by practice. Thus it has been assumed that if footbridge equipment could be eliminated in erecting wire cable suspension bridges a very material saving might be realized. Early suspension bridges, particularly those over the Ohio River promoted by Laub, had been erected without footbridges, the parallel wires being assembled into convenient erection bundles on the river bank. The last of these Laub bridges, that at Parkersburg, W. Va., was completed in 1916, but again in 1927 the cables for the bridge at Portsmouth, Ohio, also were erected successfully without resorting to footbridges. With the first major installation of shop-manufactured strands on the St. Johns bridge at Portland, Ore., last year, the method was resurrected. However, upon the two subsequent strand-cable bridges, at Maysville, Ky., and Bucksport, Me., the engineers have required the use of footbridges. Apparently it had been found that little time was saved by dispensing with the footbridge and that much better inspection was possible if a footbridge were used. It was also apparent that wrapping operations required some kind of a working platform and that by the time this platform had been slid along the full length of the cables a footbridge had in effect been built. Unless some new method is developed to assure proper cable inspection and efficiency in wrapping without the use of a footbridge this well-known piece of equipment seems destined to continue to play an important part in erecting the suspension bridges of the future regardless of the type of wire cable used.

Walls, Windows and Workmen

CONSTRUCTION materials and methods of building have always been inextricably bound together. For each material there has been a clearly defined method of use that determines basic erection procedure and to a considerable degree affects the form of the ultimate structure and its fundamental design. Stone, the principal building material of the Middle Ages, was best laid up by hand. Its outstanding characteristic as a building material—resistance to compressive stresses—played an important part in fashioning the massive walls of medieval fortresses and the inspiring flying buttresses of the thirteenth century cathedrals. Stone masons are still indispensable, even though the stone in modern construction may be lifted into place by high-speed hoists. Timber structures require the carpenter, while the buildings themselves are limited in height and breadth of span by wood's load-carrying limitations. Concrete was able to adapt the carpenter as a form builder, but steel brought forth an entirely new order of workmen. Both materials revolutionized the design and architecture of structures.

These remarks are engendered by recent radical developments in exterior wall construction in which such new materials as metal sheathing, metal decorative finish and glass are beginning to replace the hitherto universal masonry wall in its various combinations of stone, brick, tile or concrete. In some manufacturing and industrial buildings and also in a few office buildings such as the new McGraw-Hill and Starrett-Lehigh buildings in New York, the Philadelphia Savings Fund Building in Philadelphia and the Bowman Building in Chicago, this development has reached an extreme in having almost the entire wall area composed of glass, steel sash and metal trim, only the narrow spandrels clinging to traditional masonry construction. Such construction effects a saving in weight and in buildings of large area it may give a saving in usable space, since the thickness of the wall with its insulation lining and interior facing will be very much less than that of a masonry wall with its exterior facing, its backing and its interior finish.

That these new wall materials, sheet steel and glass, will have a profound effect on architectural appearance is already evident. In the new McGraw-Hill Building the motif is one of horizontal bands—dark spandrels alternating with the window areas. The Philadelphia building is similar, with its spandrel bands less conspicuous. A vertical motif could as easily be created by running continuous steel trim up the column pilasters.

An even more significant change may be expected on the labor market should this new wall construction become extensive. Bricklayers, whose swinging scaffolds entirely surrounding a new steel frame have been a familiar sight, signalizing the inclosure process, will be almost eliminated from the picture. Certainly the scaffolds will disappear, for brick backing, should it survive, will be placed from the inside of the building. Stone masons and perhaps plasterers will not be important workmen on these new walls. In their stead will be the metal-working trades, glass and sash installation experts, and probably insulation specialists. Whether a larger or a smaller number of workmen will be required is not closely predictable. It is certain, however, that an important part of the builder's working organization will be radically altered and that some skilled trades now holding key positions will become subordinate.

The building industry and engineers generally are constantly thinking in terms of new materials or new uses for old materials. It is well to extend this thinking deeper than merely to study the monetary economy involved, for there are also technical and sociological problems of the first order that must be met. The present tendency in building wall development furnishes a striking example of this fact.

Marshaling Water Needs

PLANNING for a major expansion and betterment of waterworks systems throughout the country has been begun by the American Water Works Association. Leaders in the waterworks field see that if much of the present discussion in Congress of granting federal aid to states and municipalities to relieve unemployment results in a large federal loan for that purpose the municipalities of the country presently will be faced with the problem of how best to spend the money that will be made available to them. If the municipalities are ready with plans for carrying out needed improvements much valuable time can be saved and work of a worthwhile character can be substituted for made-work in emergency unemployment relief. But if no plans are in readiness utilization of federal aid will be postponed, if not made impossible.

In most cities either the water-supply or water-distribution system, or both, can be expanded or modernized to advantage. Some city water departments have definite expansion plans formulated; others know in a general way what their needs are but could not say on short notice how much money they can use or just where to apply it; still others have even less definite knowledge of their needs. Filling in these important gaps in waterworks plans is the primary purpose of the work being undertaken by the American Water Works Association.

The secondary object of the association betterment planning, however, relates directly to the organization needed if the anticipated federal-aid measures are passed. It calls for the setting up of coordinating bodies and the drafting of additional legislation to make it possible for municipalities to obtain and put to work the funds that the federal government may make available to them.

This part of the work will be of value to municipal undertakings for relief work other than water supply. Betterment of sewage and refuse disposal systems, of street paving and traffic routes and of transit facilities also holds possibilities for productive work, even though most of these latter can show no such direct financial return. Outside of the cities there also are opportunities for advantageous use of relief funds on road and on railway grade-crossing elimination work. In many instances state road work and city street paving is already well laid out and in a few states plans for crossing elimination have been projected well in advance of present work, but in most of the other possible fields of activity there is little advance planning that could be made the basis for an immediate application for federal-aid funds.

Here is an opportunity for other organizations to follow the lead of the American Water Works Association. The forehandedness of the leaders in that organization who have undertaken the waterworks betterment planning may be the deciding factor in greatly increasing activity in that field during the next few years regardless of whether the activity is stimulated by an emergency federal-aid program or by a revival of business activity.

Speedy Erection of Parallel-Strand Cable Bridge

On Ohio River structure of 1,060-ft. span at Maysville, Ky., towers were erected in eight days and cables in nine days using footbridges—Aluminum fillers transform hexagonal cable to a 13-in. circle for wrapping

CHARACTERIZED by several important innovations in design and an unusual erection speed, the new suspension bridge over the Ohio River at Maysville, Ky., which was opened to traffic Nov. 25, assumes a place among the four long-span bridges of parallel-strand type built since the manufacture of bridge strands of high and uniform modulus of elasticity was perfected about three years ago. The design elements of interest center in the cable make-up and anchorage details. That erection speed was unusual is evident from examination of the statistics of the job which show that the towers were erected (not riveted) in 3½ and 4½ working days, respectively, and that the cables were erected in nine days. Contrary to previous practice (except for the bridge at Bucksport, Me., under construction simultaneously) and even to general opinion concerning the economics of strand cable erection, footbridges were used with satisfaction and success.

The Maysville bridge is one of the large group of public toll structures being built by the Kentucky state highway commission to replace many old ferry crossings. It connects Maysville, Ky., with the village of Aberdeen, Ohio, and ties the highway systems of the two states together. This bridge has a main span of 1,060 ft., with suspended side spans 465 ft. long. Plate-girder approaches provide access to the bridge at either end. Gravity anchorages are used. The two towers are 165 ft. high above the piers (225 ft. above pool stage) and each contains 350 tons of structural steel. Both towers rest on offshore piers sunk with air caissons. Each cable is made up of 61 prestressed twisted strands laid parallel in the cable, giving a finished diameter of 13 in. Cable bents are utilized at each end of the bridge to change the slope of the cable and shorten the distance between anchorages. Stiffening trusses 14 ft. deep and 28 ft. apart are suspended from 1¾-in. diameter suspender ropes and support a 20-ft. concrete slab roadway and one 4 ft. 8 in. sidewalk at about midpoint between the chords. The bridge provides a 45-ft. clearance at the center of the river at highest high water.

At the present time "innovations" in design of strand cable bridges mean departures from practice used on the three other structures of the type, the Grand' Mere bridge in Quebec, the St. Johns bridge in Portland, Ore., and the Waldo-Hancock bridge at Bucksport, Me. In this article only the St. Johns bridge is considered for comparison, because it is the largest and most notable and because the Grand'Mere bridge is not a typical structure in most particulars; the Waldo-Hancock bridge was under construction simultaneously with the bridge at Maysville and involves numerous innovations on its own account. These features will be covered in a future article.

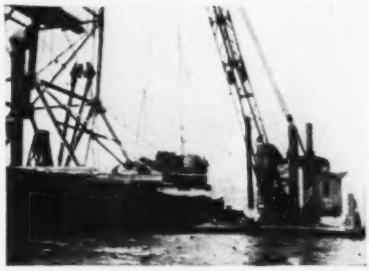
On the Maysville bridge, the make-up of the hexagonal cable claims first importance. Instead of making all strands the same diameter as was done at St. Johns, the strands forming the corners of the hexagon are 0.942 in. in diameter, while the remainder of the 55 strands are 1.556 in. in diameter. Such an arrangement provides the same steel area as if all the strands had been made uniformly 1½ in. in diameter and at the same time reduces the over-all diameter of the finished circular cable, effecting a saving in wrapping costs as well as reducing the size and therefore the cost of saddle castings and cable clamps. The modulus of the large and small strands is the same, since the lengths of the various wires measured along the helix do not vary.

It is also a fact that in a hexagonal cable made up of a number of equal diameter strands, the strands forming the corners of the hexgon protrude to such an extent that segmental fillers of considerable size are required to fill out the cable to a circular cross-section. Eliminate these corners by using smaller strands and much smaller fillers are required to fill out the circle. This possibility of using small fillers had much to do with the decision to use two sizes of strands in the Maysville cables, for the engineers had prohibited the use of wood fillers, and aluminum fillers costing about three times as much as the wood fillers in the St. Johns cables, had been adopted. These aluminum fillers were in line with the engineers' desire to assure maximum permanence in the cables. They were installed in 24-ft. lengths and their arrangement in the cables is shown in Fig. 4.

At the cable bents an abrupt change in cable inclination occurs, with the result that the cable stress in the backstay is considerably larger than the adjacent stress in the side-span cable. To compensate for this increased stress and to prevent the cable bent saddle from slipping along the cable a tier of four 1½-in. diameter strands was added to the bottom of the cable between the cable bents and the anchorages. It was not practicable to utilize aluminum for the large segmental fillers required to finish out

Fig. 2—Maysville bridge furnishes a 20-ft. highway over the Ohio River.

Fig. 1—Strand-cable suspension bridge joining Maysville, Ky., and village of Aberdeen, Ohio, is an important structure in Kentucky's current tollbridge building program.



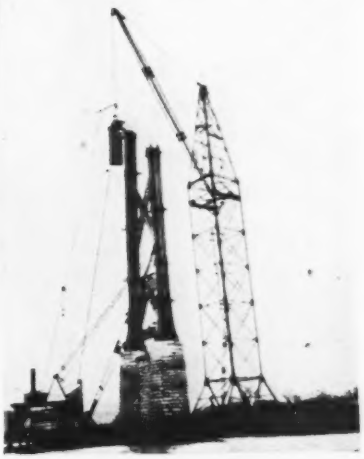


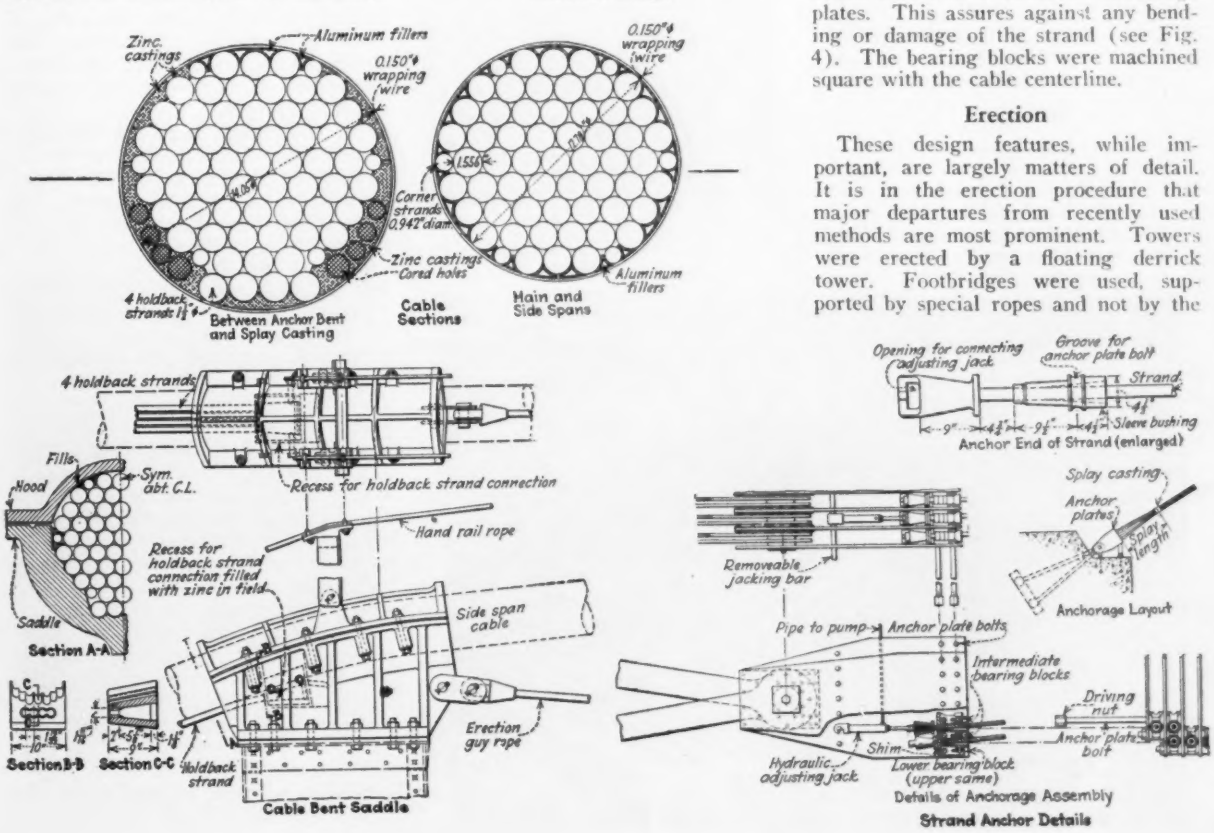
Fig. 3—Floating tower-derrick erected both bridge towers in eight days, including placing cable-erection equipment, as shown at left. The electric hoisting engine placed on an outrigger platform served as counterweight for derrick boom (above). (Right) Steel picked direct from supply barge. Note riveting scaffolds which were attached to leg sections of tower in the barge before erection.

the circle in this portion of the cable, and zinc castings, cored out for lightness, were used as shown in Fig. 4.

In the St. Johns bridge these additional backstay strands were fastened to the sides of the cable bent saddles several inches below the bottom strands of the cable in the saddle grooves. As a result the added strands did not become tangent to the bottom strands of the cable for some distance from the saddle casting, making wrapping in this section impossible and requiring a metal hood for weather protection. At Maysville an ingenious design of saddle casting was worked out (Fig. 4) that keeps the added strands tangent to the main cable strands throughout their entire length. Wrapping was applied right up to the casting, as may be seen in Fig. 2. Lead wool calking sealed the annular opening at the face of the casting, and no hood was necessary.

A change from the anchorage arrangement used at St. Johns was also effected at Maysville. Beyond the splay point at St. Johns the strands of each cable were divided into nine parts terminating in nine sets of anchorage plates. At Maysville a single set of plates is placed symmetrically about the center line of the cables. This simplifies the splay arrangement and produces a more compact anchorage, making possible a reduction in the over-all width of the anchorage block. The strands are fastened in the anchorage plates by steel end sockets that bear against cast-steel blocks bolted between the plates. Cast-steel sleeves attached to the strands in the shop protect the strand where it passes between the bearing blocks. These sleeves are cast with an interior radius to accommodate the inclination of the strand as it leaves the anchorage plates. This assures against any bending or damage of the strand (see Fig. 4). The bearing blocks were machined square with the cable centerline.

Fig. 4—Cable and anchorage details, Maysville bridge.



Erection

These design features, while important, are largely matters of detail. It is in the erection procedure that major departures from recently used methods are most prominent. Towers were erected by a floating derrick tower. Footbridges were used, supported by special ropes and not by the

suspender ropes, as is usual practice. Stiffening trusses and floor steel were placed by a derrick boat with a 130-ft. boom.

Tower Erection—Inasmuch as both towers are located in the river, the contractor elected to erect them with floating equipment. Their height precluded the use of a standard derrick, and a special derrick-tower plant was developed. This erection tower is of steel, 200 ft. high, and consists of three principal parts—a wide base made up of trusses resting on timber grillages and spread across two steel barges tied together, a main shaft 21 ft. square, and the derrick mast and boom which are mounted on top of the main shaft. The mast is a pyramid-shaped extension of the main shaft and was in fact used as a cableway tower in constructing the New Jersey anchorage of the Hudson River bridge in New York. The boom of the derrick is 125 ft. long, a boom seat being provided on the center line of the tower. Guy lines attached to the corners of the barges serve to brace the tower. In addition, the three-drum, 125-hp. electric hoisting engine that is used is set on an outrigger platform at the base of the tower to serve as a counterweight for the derrick boom. In assembling the erection tower, a derrick boat placed the lower panels on the barges, while the remainder of the tower was erected by a gin pole jumped up inside the tower. Two drums of the hoist were used for load and boom lines. The third drum operated a line guy from the top of the erection tower to the anchorage, the tower being maintained in a vertical position by manipulation of the guy line drum.

All erection equipment on the job was electrically operated. Since electric power was not available on the Ohio shore, a special submarine cable was laid from Maysville, Ky., across the river, to furnish current to the Ohio tower and anchorage.

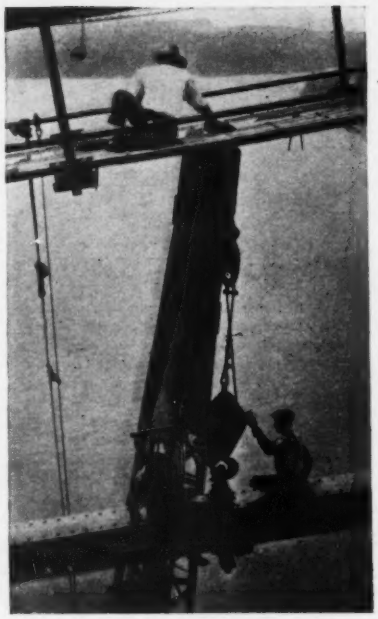


Fig. 5—Use of footbridges for parallel-strand cable erection was important innovation on Maysville bridge. View shows boom of floating derrick setting stiffening truss but also gives good idea of footbridge make-up. Note wood crossbeams held between angle clamps, also perforated channel posts permitting vertical adjustment of footbridge.

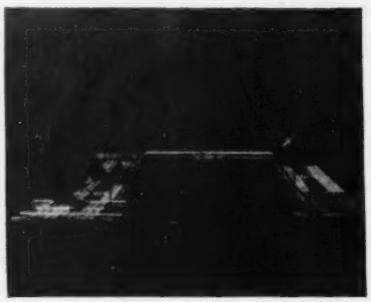


Fig. 6—Erecting footbridges by sliding trains of platform sections down ropes from tower tops.

Fig. 7—Cable strands wound on special reels in the field were pulled across the river by an endless tramway rope. Note the compact anchorage requiring a minimum splay of the strands.

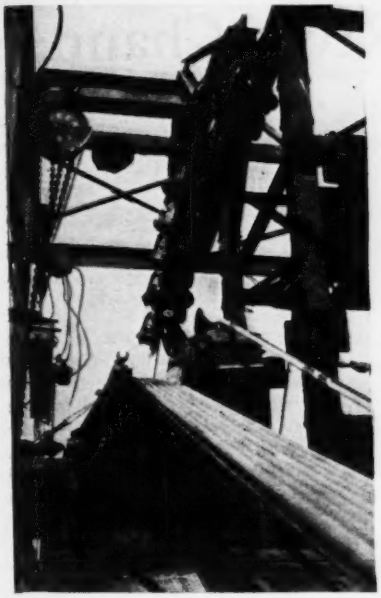
The bridge towers are of the usual braced-leg fixed-base type. Silicon steel is used. Above the roadway the legs are braced by 2½ panels of X-bracing. A horizontal strut is used at the top of the tower. Below the floorbeam is one-half panel of X-bracing and a horizontal strut, 7½ ft. above the top of the pier. Each leg is cellular in cross-section, consisting of a comparatively wide center cell with narrow cells front and rear. Erection pieces varied in length up to 46 ft. maximum and in weight up to 28 tons.

The Ohio tower was erected first. Steel came to the job in barges, carefully loaded so that no sorting on the job was necessary. The column bases were set by a derrick boat. Then with the derrick-tower plant lashed to the landward side of the pier, the steel supply barge was anchored to the opposite side. This permitted the erection derrick boom-line to be dropped directly to the steel barge and the steel to be lifted almost vertically into place. Inasmuch as the derrick boom had only about a 10-ft. swing, it was possible to erect only one leg and the bracing from the first position. The derrick tower was then dropped down the river about 20 ft. and the second leg erected. All steel in the Ohio tower was placed in 4½ working days, after which a stern-wheel steamboat moved the erection equipment to the Kentucky tower where the procedure was repeated. With the experience gained in erecting the Ohio tower, it was possible for the erector to place all of the steel in the Maysville tower in 3½ days.

An interesting detail of the tower erection was the attaching of riveting scaffolds to the tower legs before they were hoisted from the barges. This made them immediately available for the raising gang as well as for riveters, and saved time in the field, which was particularly advantageous, since riveting was by far the most time-consuming element of the erection procedure.

The contractor was well satisfied with the use of the floating derrick tower. Work continued in spite of a protracted period of high water, the only difficulty occurring from driftwood that lodged against the barge and pier. Inasmuch as the barges were lashed to the pier, this driftwood was removed with difficulty. On a similar future job, the tower derrick barges would probably be held in position by anchor lines, which will permit easier maneuverability.

Footbridges—The engineers' specifications for the Maysville bridge required that footbridges be used when erecting the cables. This is contrary to previous practice on parallel-strand cable bridges, but was believed advisable by the engineers in order to assure proper inspection, efficient adjustment of the strands and satisfactory wrapping.



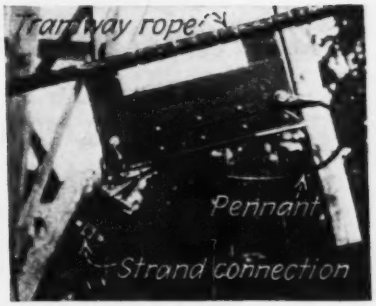


Fig. 8—In constructing the Maysville bridge cable the tramway rope to which strands were connected through a plate and pennant-line (center) was carried at the tower top by a line of deflector sheaves (left). Strands which were supported at the tower tops on four rollers while being hauled across the river were lifted into the saddle by a chain hoist (left and right). In right-hand view note right- and left-lay strands in adjacent layers.

Suspender ropes on this bridge were prestressed, cut to length and socketed in the shop and sent to the job ready for erection. This precluded the use of the suspender ropes for footbridge ropes, as has been previous practice. Accordingly, four ungalvanized ropes 1¾ in. in diameter and long enough to reach from anchorage to anchorage formed a part of the footbridge equipment.

The footbridges designed by the contractor were entirely of wood, with the exception of the channel-iron uprights placed at the end of each 10-ft. floor section. Thus they were light and easy to handle. The floor sections were 6 ft. wide, made up of three 8-in. wide planks at either side with a 2-ft. strip down the center covered with wire mesh which served the twofold purpose of lessening the weight of the footbridges and later of permitting openings for the suspender ropes to be made easily. Cross beams (Fig. 5), placed at the end of each floor section, were two 4x4-in. timbers fastened to the channel-iron posts by small angle clamps, which eliminated the necessity for any bolt holes in the timbers. Bent-plate clevises fastened to the channel posts served as hooks to attach the footbridge to the footbridge ropes. Holes punched in the webs of the channel posts on about 3 in. centers made it possible to place the footbridges at variable distances below the ropes. Such adjustment permitted the footbridges to be lowered as the main cable, under its own weight and the weight of the suspended floor steel, sagged down. On previous suspension bridges the foot bridges have been transferred to lashings passing over the main cables when it became necessary to remove the footbridge ropes and cut them up for suspenders. Under such an arrangement the distance between the cables and the footbridges did not vary as the cable sagged down, but with the footbridges entirely independent of the cables their vertical adjustment became a necessity. The adjustment provision at Maysville proved entirely satisfactory.

As an initial operation in erecting the footbridges, a 1-in. diameter endless tramway rope was carried from the Kentucky to the Ohio shore and back again by a steamboat, and lifted to supports on top of the towers. Machinery for operating the tramway was placed on the Ohio anchorage. This tramway pulled the footbridge ropes across the river and later erected the cables.

With the footbridge ropes in place, the footbridge sections were hoisted to the tops of the towers and slid down the ropes in trains (Fig. 6). This proved an unusually rapid means of erection, and the footbridges, including ropes and platforms, were placed in six days. The final operation in the erection of the footbridges involved the placing of the storm system. This included a single rope for each footbridge, fastened near the base of each tower and pulled up into an arch outline by means of bridles hung from the footbridges.

Cable Construction—With the completion of the footbridges, headframes were erected along them to support the tramway ropes that hauled the bridge strands of the cable across. Deflection sheaves were also placed on top of each tower and at the cable bents to support the tramway rope at these locations. A strand connection consisting of a plate with a pennant line and clevises (Fig. 8) was attached to the tramway line at both the Maysville and Aberdeen anchorages, one serving each cable. By shuttling these connections back and forth across the river, the strands were laid and the cables built up.

All strands were received by rail on the Kentucky shore and transferred to a special reel stand on the Maysville anchorage block. The tramway carried the Ohio end of only one strand per

Fig. 9—Wrapping the Maysville strand cable which was brought to a circular section by the use of aluminum fillers.

Fig. 10.—Stiffening trusses and floor steel were lifted into place with 130-ft. boom of crane mounted on float.

trip, and strands were placed alternately in each cable.

At the tower tops the strand as it was hauled across was supported on four large cast-iron wide-mouthed sheaves set tandem. After attaching the ends of a strand at both anchorages, the strand was transferred from the sheaves to the saddle by means of a chain hoist and a balance beam. The strands were placed in the cable in layers, strands in adjacent layers being of opposite lay to assure line bearing instead of point bearing between the wires of strands in adjacent layers at all turning points of the cable. Also, the use of alternate layers of right- and left-lay strands provides resistance against a rolling effort on the part of the cable caused by the inherent tendency of each strand to rotate as load is applied. In the right- and left-lay construction the rotational tendency of one layer of strands is resisted by the same tendency but in the opposite direction in the adjacent layer.

The cables were erected in nine days, or a layer per day in both cables. No faster progress was possible because each layer had to be adjusted before another layer was added, and this adjustment could only be done correctly after the sun had gone down.

The suspenders were hoisted to the tower tops and slid down the footbridges to their proper locations. The stiffening trusses and floor steel in the main span and in the portions of the side spans near the towers were lifted into place from barges by means of a derrick boat with a 130-ft. boom. On the portions of the side spans on shore that could not be reached by floating equipment a cable-traveler operated by an engine on the shore set the stiffening trusses and floor steel. No compacting of a bridge strand cable is necessary but after the aluminum fillers had been applied to fill out the cable to a circular section, a double-spool wrapping machine similar to the one used on the Hudson River bridge wrapped the cable with No. 9 soft-annealed galvanized wire.

Administration — Contracts for the Maysville bridge were let Oct. 8, 1930. The bridge was opened to traffic on Nov. 25, 1931. The Dravo Contracting Co., of Pittsburgh, started work on the foundations immediately after the contract was let and had the piers and anchorages ready so that steel erection started April 1, 1931. The John A. Roebling's Sons Co., Trenton, N. J., erected the entire bridge as well as manufactured and furnished the cables. For this company C. C. Sunderland was chief engineer, C. M. Jones assistant chief engineer, R. J. Cole resident engineer, and Wade Klein superintendent of erection. The Maysville bridge was designed and the erection supervised by Modjeski, Masters & Chase, Harrisburg, Pa., for whom C. W. Hanson was resident engineer. For the state of Kentucky, H. D. Palmore is chief engineer and H. R. Creal bridge engineer.

Maintaining River Channels by Shoal Dredging

Location and occurrence of shoals—Mobilizing for dredging—Parallel cut system employed—Dustpan suction head preferred

By J. J. Sullivan

Assistant Engineer in Charge of Channel Maintenance, First Field Area, Memphis Engineer District, Cairo, Ill.

TWO SUCCESSIVE SEASONS of extremely low water in the Mississippi River are making necessary an amount of channel maintenance work that is putting to test the dredging-equipment resources of the government engineers responsible for maintaining navigation. Even old dredges which had supposedly been retired from active service have been called back into the fighting line and forced to wage battle with the "rising bottom." Dredging for channel maintenance is primarily a task of cutting through shoals which form mostly at reverse bends where the channel crosses the river. It calls for a type of organization mobility and of planning and operating technique quite different from ordinary channel-deepening and land-filling operation. These characteristics are notably well presented in the article that follows. —EDITOR.

THE general course of a river through an alluvial valley is a succession of reverse curves (see Fig. 1) called bends, which are of widely varying lengths and degree of curvature. In the upper part of the river the bends are short and sharp, but as the lower limits are approached there is a gradual increase in length and decrease in degree of curvature. The thalweg of the river is parallel to and from 200 to 600 ft. from the outside bank of the bends. Where two reverse bends join, the thread of the channel leaves the upper bend a short distance above its lower end or foot and joins the lower bend a short distance below its head. This place is called a crossing, as the channel crosses from one bank to the other, and, except in extraordinary cases, all shoals are found at these places.

From New Madrid to Helena is the most difficult section of the Mississippi River in which to maintain a navigable channel. Owing to greater slope there is a stronger current, resulting in excessive bank erosion. There are also many islands, with a possible channel on either side. The increased width of river also increases the possibility of more than one channel through the bars. In this section the most troublesome part is above Memphis, which comprises only 66 per cent of the distance but contains 80 per cent of the shoals. The accompanying table indicates the conditions.

LOCATION OF MAXIMUM SHOAL FORMATION AND DREDGING OPERATIONS

Districts	Miles in District	Slope Per Mile-Ft.	No. of Shoals Dredged	Per Cent of Shoals
Cairo to New Madrid..	71	0.25	4	2
New Madrid to Helena	236	0.49	159	83
Helena to Vicksburg...	295	0.32	11	6
Vicksburg to mouth Red River.....	171	0.25	17	9
Mouth Red River to New Orleans.....	192	0.25	0	0

Below Helena a gradual change takes place in the character of the river, the decreased slope resulting in fewer caving banks and the width being more uniform. The first large tributary enters 12 miles above Helena and between there and the mouth of Red River three other rivers enter to increase the discharge. This increased volume is taken care of by greater depths. Except in extremely low water, dredging operations below Helena have been confined to a few crossings. Dredging to maintain channel is not found necessary below Red River.

When the gage at Cairo registers 22

Fig. 1—Typical section of river showing shoals at crossovers of channel.

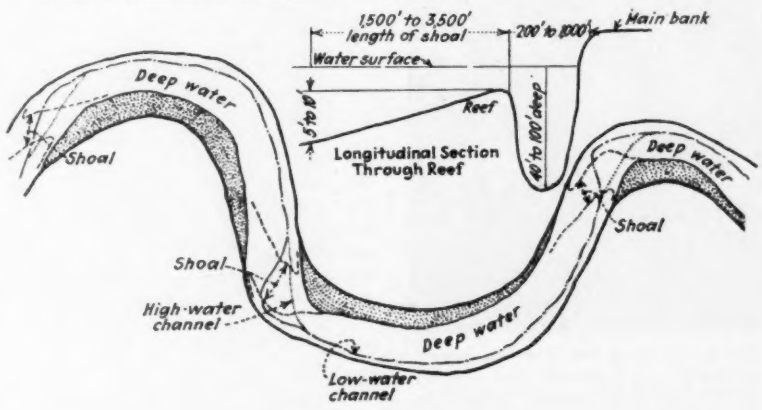


Fig. 2—Sandy Hook, Aug. 3, before dredging started.

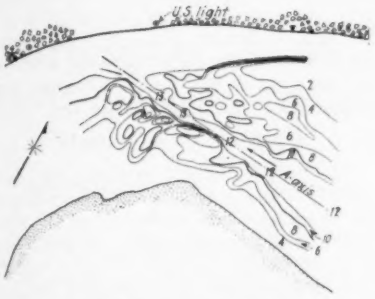


Fig. 3—Sandy Hook, Aug. 18, after dredging on *A* axis, remained open three weeks.

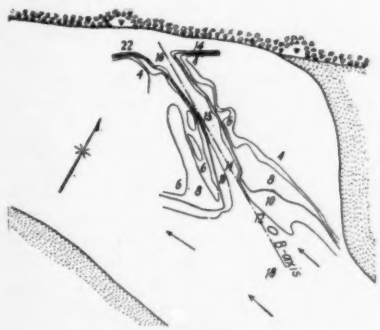


Fig. 4—Sandy Hook, Nov. 13, after dredging on *B* axis, remained open full season.

ft. and the upper river is falling, dredges are prepared for service in the river above Memphis. Two dredges are dispatched to points centrally located to be immediately available when shoals are found. Two small boats, with a surveyor in the crew are sent out in advance of the dredges to investigate channel conditions and determine the probable location of early dredging operations. As the stage recedes, additional dredges are sent above Memphis and another survey boat is ordered to the lower section of the river. One dredge is generally stationed between Memphis and Helena, and one below Helena. Three dredges are required above Memphis during an average low-water stage, while in extreme cases it has been necessary to operate five dredges. The average low-water season extends from the middle of July to the middle of December.

The survey-boat crew makes inspection trips over the river as often as practicable, taking soundings over all crossings in addition to making surveys of all shoals where dredging is anticipated; it sets buoys, places temporary shore marks to define the channel and changes the location of lighthouse district aids when the thalweg changes materially. Surveys are also made upon completion of dredging operations to determine the results of the work and reset buoys if necessary. Before improvement of a shoal is undertaken it is desirable to have two preliminary surveys in order to determine the natural trend of the channel. It is practically impossible to hold a channel if the wrong location is dredged, whereas comparatively little difficulty is experienced if improvement conforms with the natural trend of the current.

Locating the dredge cut

In locating the axis for dredging it should invariably join the upper pool above its lower point and the lower pool below its upper extremity. (See Fig. 1, low-water channel.) Where the reef is between two sand bars and the section is wide, it is a matter of experience to locate the proper place for improvement.

When a channel deteriorates rapidly after being dredged two or more times, a new location should be selected for improvement if possible. Fig. 2 shows a preliminary survey of Sandy Hook Crossing and Figs. 3 and 4 are later surveys of the same place. From three preliminary surveys, axis *A* was decided on as the line of dredging. Although it joined the upper pool at its lower extremity, all other indications were that this was the most feasible location, the three surveys showing only minor changes. Dredging started when there was a least depth of 13 ft. in the crossing. Fig. 3 shows conditions immediately after dredging. This channel remained in good condition for three weeks, when dredging was again necessary. Prior to Nov. 5, when axis *B* was decided upon for improvement, it was necessary to open this channel by dredging six times. A total of 365,000 cu.yd. of material was moved. A dredge was placed on axis *B* which had a mini-

Fig. 5—Darnells Crossing, Aug. 17, was dredged four times on *A* axis.

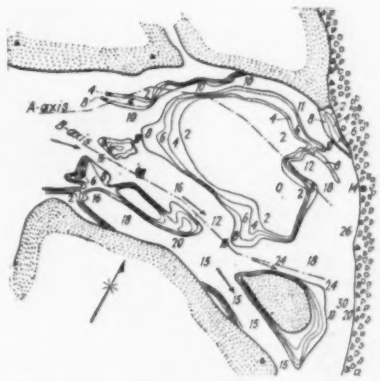
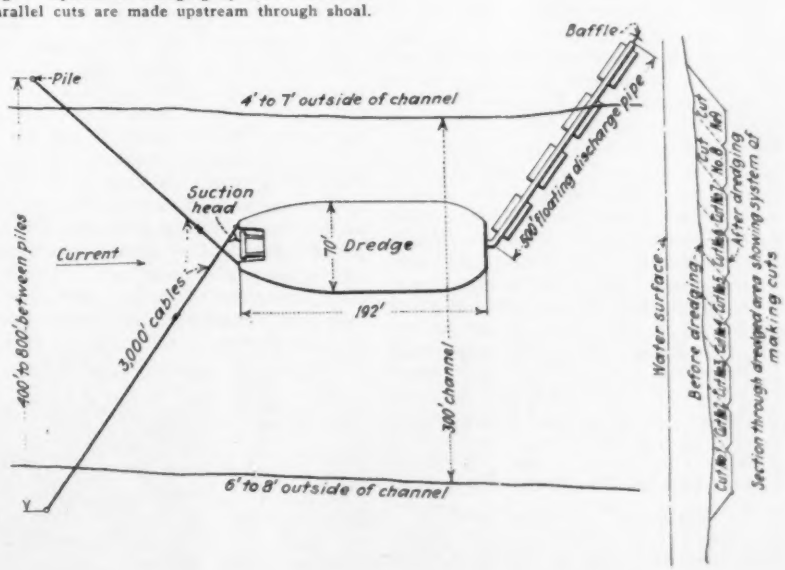


Fig. 6—Darnells Crossing, Nov. 10, shows new natural channel on *B* axis following a slight rise.

Fig. 7—System of dredging by which series of parallel cuts are made upstream through shoal.



mum depth of 5 ft. on Nov. 7. At this time there was an 8-ft. channel at axis *A*. It was necessary, on account of the extreme shoal, to move 100,000 cu.yd. to obtain the channel shown in Fig. 4, but no further difficulties were experienced that season. Preliminary surveys of the next two low-water seasons showed conditions the same as Fig. 2, but in each case axis *B* was dredged and only one operation was necessary. This is an example of an unsuccessful attempt to make a lower or point way channel and of making a channel from the lower point of the upper pool. A peculiar feature of this crossing is that after axis *B* was improved the strong current remained at axis *A* and it filled rapidly in spite of the current.

A preliminary and later survey of Darnells Crossing are shown in Figs. 5 and 6. This is a shoal between two bars, and axis *A* was decided on for improvement. It is an upper channel as it follows the general line of the upper bar, but it also joins the upper pool at its lower point. Although a navigable channel was maintained, it was necessary to dredge on four different occasions and move a total of 450,000 cu.yd. It will be noticed that the position of the upper channel in Fig. 6 is not on axis *A*. This change was gradual and consistently toward the upper bar, which is a typical movement. A slight rise occurred after dredging on Nov. 10, and Fig. 6 shows conditions after the stage had receded. Axis *B*, a channel following the general line of the lower bar, had improved without artificial aid. This change had probably started while axis *B* was being improved, and the rise aided the scour. During the next spring rise the channel at axis *B* was obliterated and that at axis *A* was maintained the next two low-water seasons with little difficulty.

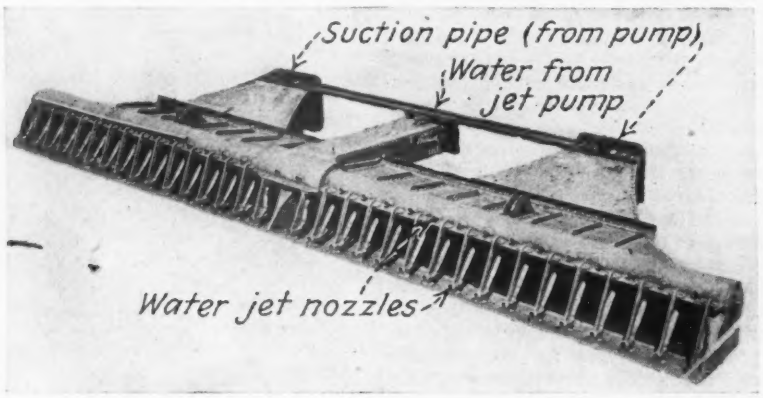


Fig. 8—Dustpan type of suction head has proved best in sand or sand and gravel formations but not in other material.

Parallel cuts preferable

The system of dredging used is a series of parallel cuts from 20 to 30 ft. wide, depending on the design of the head of the suction and the size of pump. (See Fig. 7.) This method is best adapted to channel dredging where there is strong current, the material is practicaly all sand and provision must be made for boats passing the dredge while at work in the narrow channel. A longitudinal section through the reef (see Fig. 1) shows the upstream side having a gradually decreasing depth. This slope is about 1 : 400 on an average crossing, whereas the downstream slope is generally 1 : 1 or greater.

Two piles are set in deep water above the shoal and are not moved during operations. The dredge floats downstream with cables attached to these piles until in deep water below the reef. Then the suction pipe is lowered and operations are started by pulling the dredge upstream with the cables. The cables are crossed (Fig. 7) in order to have better control of the plant. When a complete longitudinal cut is made the dredge again floats down and the operation is repeated. Great care is exercised in floating down to lay cables at the side of the previous cut, as in dredging upstream the dredge will follow approximately the line on which the cables are laid. Experiments have been made with a special suction head to dredge both upstream and downstream, but owing to lack of control when dredging downstream this plan was not successful. When a mud lump is encountered, the crossed cables make it possible to hold the dredge on range, as otherwise the plant would slide around the lump.

The material is carried through 400 to 600 ft. of floating pipe line and deposited outside the channel, preferably on the downstream side. An adjustable plate at the end of the pipe line is used to deflect the pipe to any desired angle with the dredge.

Dustpan suction head best

The suction head in use is known as the dustpan type (Fig. 8). Agitation is by water jet, which is the most practicable method in sandy material with this type of head. Experiments made with cutter agitators on early dredges were not successful due to extra weight and inability to hold bearings.

The dustpan pull-ahead method has many advantages over the swinging cutter-head method which many advocate for channel maintenance. Less time is lost in moving out of channel (often 200 ft. in width) to permit boats to pass with tows, as it is necessary only to raise the suction and slack one cable. After the boat passes, the cable is tightened and the dredge swings back to the point where operations were suspended. A swing-type dredge must have extra anchorages or move out slowly by walking with the spuds. If each type is self-propelled, no attendant plant is required for the parallel-cut method, as piles are set only at the beginning of operations, whereas with the swing type the anchors are changed as the dredge advances and a piledriver and tug are required.

Utilizing aid of current

In the parallel-cut method, the first cut plows a furrow through the crust of the shoal and induces the aid of the current for subsequent cuts. It has been estimated that from 25 to 50 per cent of the material moved is carried by the current. With the swinging type a complete longitudinal cut is not made until the work is finished; therefore the current gives very little aid and it is necessary to lift all the material through the pump. In an experiment with a dredge of each type working in the same crossing at different times during the same season the swing type required practically twice the time to make a channel as the dustpan pull-ahead dredge, although the stage of river favored the swinging dredge, as it was unnecessary to move out of the channel to permit boats to pass. This saving of time is important, as two crossings a week are sometimes necessary to keep a channel open.

The swinging dredge will leave a uniform depth, but the ridges left between parallel cuts are flattened out by the current. The cutterhead swinging method is vastly superior if the material is other than sand or gravel, as it is only possible to hold the pull-ahead type on range successfully in gravel and sand. However, 95 per cent of the material encountered is sand or sand and gravel. In a few instances lumps of mud have been left and their removel was effected with difficulty.

Volumes handled

The amount of material to be moved in making a single channel in this district varies from 25,000 to 100,000 cu.yd. and averages 60,000 cu.yd. The cost per cubic yard also varies greatly, depending on the duration of the low stage and the number of crossings improved, it being necessary to maintain dredges in the field during the low stage of the river in anticipation of rapidly developing shoals.

The number of dredges required depend on the rate of fall of the stage and the minimum stage recorded. If the change from high to extreme low stage

is rapid, shoals develop quickly. If an extreme high water extending over a long period occurs in the spring, it generally obliterates all signs of the previous low-water channel and is followed by many extremely shallow shoal crossings in the fall. In some years eight dredges have been unable to maintain a channel of project dimensions at all times, while in other years it was necessary to operate only three or four dredges.

A system of regulating works is now being constructed for the stabilization of the low-water channel and its contraction in wide shoal reaches. Yet it is not likely that dredging will be eliminated. However, navigation conditions will probably be much improved and the normal dredging equipment will be able to maintain a channel of project depth and width under the most adverse conditions without difficulty upon completion of this project.

Corrosion of Hot-Water Pipes Halted by Venting Feedwater Heater

By A. W. Blohm

Assistant Sanitary Engineer, Maryland State Department of Health

MORE efficient removal of dissolved oxygen from the hot-water system of the Maryland House of Correction through the installation of a vent condenser on the boiler feedwater heater has halted the rapid deterioration of the piping from corrosion. The institution's water supply comes from a rapid sand filter plant whose effluent is normally somewhat acid. Correction of the pH by addition of soda ash failed to relieve the corrosive action of the water.

In 1919 a slow sand water filtration plant of 300,000 gal. per day capacity was placed in operation at the institution. Except for occasions of excessively high turbidity no chemicals were applied to the water prior to filtration. The water was disinfected with liquid chlorine after filtration.

Because of difficulties in operation and of the growth of the institution, the slow sand filtration plant in 1927 was converted to one of the rapid sand type, with a capacity of 500,000 gal. per day. The new plant obtains water from the same source. Since its installation the water has been treated with coagulant to produce a satisfactory floc; chlorination of the filter effluent has been continued.

Corrosion—After the new plant had been in operation a short time, red water was noted in the hot-water pipe lines. Tests indicated that the filtered water had a pH ranging between 6.6 and 6.8. In order not to increase the scale formation in the boiler tubes, soda ash was used to raise the pH to 7.0. This treatment was continued from October, 1928, until October, 1929. With the wide fluctuation in daily water consumption, ranging from 110,000 to 278,000 gal. per day, it was apparent that it would be difficult to prevent occasional if not frequent acid pH readings; the operator was therefore advised to increase the amount of soda ash to maintain a pH around 7.6.

At this time it was necessary to replace the boiler feedwater line. The line, consisting of 4-in. and 2½-in. wrought-iron pipe from the heater to the boilers, had been in service two years and was badly pitted, indicating apparently a typical oxygen form of corrosion.

The boiler water is heated by an open heater, which receives the return water from the hot-water lines and also any make-up water. The water flows from the make-up tank by gravity into the heater and the heated water is pumped from the heater into the boilers. Although many dissolved-oxygen tests made on the feedwater heater failed to indicate any dissolved oxygen, one showed 9.6 per cent saturation. Several inspections led to the opinion that the vent on the heater was too small to relieve the oxygen completely. It appeared that the oxygen was being trapped in the heater and at intervals was being discharged in slugs into the feedwater. Any corrosion due to the use of dissimilar metals had been eliminated some time prior to this study, and it was thought that the heater was in a measure responsible for the continued corrosion. Accordingly, the installation of a vent condenser was recommended. Although this action was not approved by the manufacturer of the heater, the vent condenser was installed in the hope of correcting the difficulties.

After it was installed, repeated tests for dissolved oxygen continued to give negative results in the tap on the heater, and some other way of measuring the corrosion was necessary. A Powell corrosion tester was placed in the inlet pipe line of the heater and one on the outlet of the feedwater pump. This tester is a device which may be tapped into a pipe line or boiler and by means of small wires and test plugs makes possible the measurement of the extent of corrosion. The test plugs used at this institution were accurately weighed before their insertion in the pipe line and were then permitted to remain in place for six months, after which time they were removed and again weighed. Inspection readily indicated a greater extent of corrosion on the one from the inlet side than the one on the outlet of the heater. The former was covered with barnacles, as indicated on the accompanying illustration, showed clear evidence of pitting of the metal, and had lost weight to the extent of 6.36 per cent, whereas the other plug was comparatively clean, gave no evidence of pitting and had lost only 0.93 per cent of its weight.

During the time the plugs were exposed the filtered water was being treated with soda ash and the operator had been careful to keep a pH reading of 7.6 at all times. The results clearly indicate the extent to which the corrosion might have been carried had the oxygen been aided by an acid condition of the water.

Fig. 1—Corrosion of test plugs by boiler feedwater. The plug on the left was exposed for six months before the heater was vented. That on the right had the same exposure after vent was installed.

Fig. 2—Corroded section of 4-in. wrought-iron pipe after two years' service.

It is evident that the high hydrogen-ion concentration in the filtered water and the high dissolved oxygen content resulting from improper venting of the feedwater heater contributed to the rapid destruction of the boiler feedwater piping.

As soon as it was learned that the oxygen continued to attack the pipe line, even though an alkaline pH was maintained in the water, the application of lime to the filtered water was substituted for the soda ash. This change in treatment was made on the assumption that the lime will deposit a protective film on the inside of the pipe and thereby retard the action of the oxygen that had caused the corrosion.

Notable Features Found in Pennsylvania's 152-Lb. Rail

Exceptional form of head has large top and corner radii—Compound curves for top corners and web—Comparison with A.R.E.A. sections

AN IMPORTANT development in rail design and track construction is the Pennsylvania Railroad's adoption of a 152-lb. 8-in. rail section and the laying of this rail for experimental service on about 10 miles of a main track on the heavily traveled New York division. While this rail is notable as the highest and heaviest section ever rolled, it is notable also in having a head with the exceptionally large radii of 24 in. for the top and 1 in. for the upper part of the top corners. Other compound curves are employed in the web. Splice bars of the fish-plate type are used for the rail joints, as noted later.

For this new rail the design was based on studies by a committee representing the railroad and leading steel mills. It was rolled by the Bethlehem Steel Corp. A high-carbon steel was used, having 0.7 to 0.85 per cent carbon, 0.7 to 1 per cent manganese and 0.15 to 0.3 silicon, with phosphorus not exceeding 0.04 per cent.

Rail Section—Previous to this development, the heaviest rail on the Pennsylvania Railroad was a 130-lb. 6⅝-in. section designed in 1916, having a 12-in. top radius with 7/16-in. corners. This rail has now been redesigned as a 131-lb. 7⅛-in. section, with head similar to that of the 152-lb. section.

The new 152-lb. rail is designed to meet traffic conditions of 100,000-lb. axle loads (or about 25-ton wheel loads) moving at 100 m.p.h., as against 80,000-lb. loads at 80 m.p.h. for the older 130-lb. section. These severe conditions represent, of course, a material increase beyond present loads and speeds, but are considered to provide for transportation developments of the next 25 years.

From calculations of stresses in rails and study of the reports of the joint committee on stresses in track, four special features were decided upon as essential for the new rail: (1) a height of about 8 in. to give increased stiffness; (2) a head with as flat a top radius as practicable for manufacture, in order to give wide contact with the wheel tread; (3) the perimeter of the head, web and base to be proportionate to their respective volumes, so as to make the rate of cooling as nearly uniform as possible and thus minimize the internal stress due to cooling; (4) the rail as laid in track to be given an inward cant or slope of 1 in 40 by inclined tieplates to assure a broad wheel contact. The 152-lb. section thus developed is said to have 75 per cent greater stiffness than the 130-lb. section.

COMPARISON OF RAIL SECTIONS

Type of Section	Penn. R.R.		A.R.E.A.	
Weight per yard, lb.	152		150½	
Height, total, in.	8		7⅞	
Height of head, in.	1 11/32		1 11/32	
Height of web, in.	4⅛		4 5/16	
Height of base, in.	1 5/16		1 5/16	
Width of base, in.	6½		6½	
Thickness of web, minimum, in.	11/32		11/32	
At height above base, in.	5		4	
Width of head, at top, in.	3		3½	
Width of head between top corners, in.	1 13/32		2⅛	
Sides of head, sloped	1 in 40		1 in 16	
Fishing angles, deg.	14		14	
Radius, top of head, in.	24		14	
Radius, top corners, upper part	1		⅛	
Radius, top corners, lower part	¼		⅛	
Radius, bottom corners of head	1/16		1/16	
Radius, top fillets	½		7/16	
Radius, bottom fillets	½		½	
Radius, corners of base	1/16		1/16	
Radius, sides of web, upper part	6		20	
Radius, sides of web, lower part	30		20	
Area, head, sq.in. and per cent.	4.8,	32	5.12,	34.7
Area, web, sq.in. and per cent.	4.3,	29	3.85,	26.1
Area, base, sq.in. and per cent.	5.8,	39	5.78,	39.2
Area, total, sq.in. and per cent.	14.9,	100	14.75,	100

A comparison of the 152-lb. Pennsylvania section with the 150-lb. section (not yet rolled) of the American Railway Engineering Association shows some marked departures from previous practice and from the widely used A.R.E.A. type of section. Thus the Pennsylvania rail has a height of 8 in., as compared with 7⅞ in. for the A.R.E.A. rail, the increase being mainly in the height of web. Its head is as flat as can be rolled satisfactorily, with a radius of 24 in., as compared with 14 in. While the sides of the head flare outward from the top in accordance with present practice, their inclination is only 1 in 40, as compared with 1 in 16 for the A.R.E.A. sections. But as the rail itself will be inclined 1 in 40, the side of the head will be practically vertical in its relation to the wheel flange.

Rounded top corners of large radius for the flat head are also distinctive and unusual, for while the ⅜-in. corner of the A.R.E.A. section represents normal modern practice, the corner of the Pennsylvania section has a 1-in. radius extending well below the top of the head and is followed by a ¼-in. radius tangent to the side of the head. In the older 130-lb. section the head radius is 12 in. and the top corner is 7/16 in., but in the modified 131-lb. section the head and corner are identical with the 152-lb. section. Still another new arrangement is the compound curve for the sides of the web, a 6-in. radius from the top fillet being followed by a 30-in. radius extending to the bottom fillet, with the thinnest part of the web at the junction of these curves, high above the center line. In the base the 152- and 150-lb. rail sections are practically identical.

Rail Joint—In the new six-bolt splice bars, 38½ in. long, for the 152-lb. rail (Fig. 2) a radical change in the design is the elimination of the flange, replacing the more usual angle-bar by a flat or fish-plate section. These bars are

Fig. 1—New 152-lb. rail, Pennsylvania Railroad. Dotted line indicates 150-lb. A.R.E.A. section.

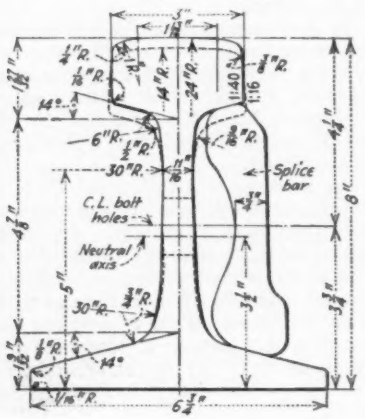
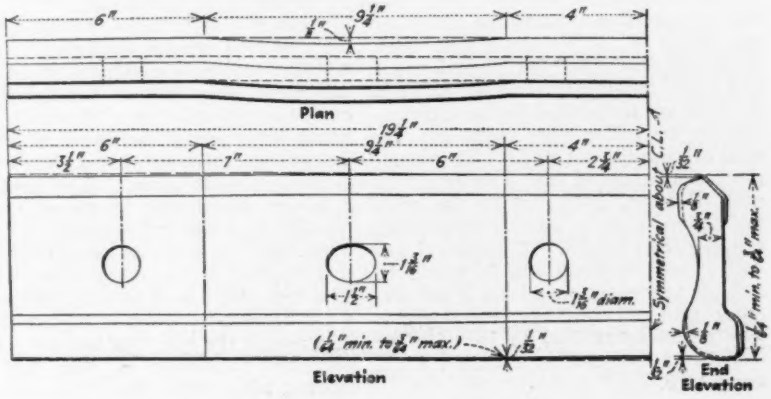


Fig. 2—Horizontal and vertical offsets are unusual features of the new Pennsylvania splice bar.



comparatively thin and only slightly enlarged at top and bottom, without the heavy ribs sometimes used in fish-plate sections. Furthermore, each bar is bent or offset both horizontally and vertically. At the second and fifth bolt holes the top and bottom ribs are offset ⅛ in. away from the rail for a length of about 9¼ in. This is designed to give flexibility, which will permit of taking up wear of the contact surfaces.

For a length of 8 in. at the middle of the bar, the top and bottom are offset upward 3/32 in. (3/64 to 3/64 in.), while for 6 in. at each end the top and bottom are correspondingly lower. According to a statement of the engineers, "The purpose of this is that, in combination with the lateral deformation or offset, the splice, when bolt tension is applied, is stressed in a torsional way, which stress is continually tending to retard wear. If such wear does occur, the splice can take it up, due to centroids of pressure being free to move inward without interference by other portions of the splice. The reaction from all bolt pressure is directly at the centroids of pressure."

Bolt spacing is 5½ in. c. to c. at the rail joint and then 6 and 7 in. consecutively toward each end of the splice. This compares with a uniform spacing of 5½ in. as included in the A.R.E.A. recommendations. Bolt holes in the bars are alternately 1 7/8 in. in diameter and 1 7/8 x 1½ in., while all holes in the rails are 1 7/8 in. in diameter.

For the pair of bars at each joint the weight is 3.5 lb. per inch, or about 133 lb. for the pair; their combined sectional area is 12.5 sq.in., as compared with 14.9 in. for the rail.

FIELD OBSERVATIONS ON HIGHWAY PRACTICES

Major Road-Widening Program in Ohio

Machine operations prevail in increasing 200 miles of 16- and 18-ft. roads to standard two-lane width or wider

By C. S. HILL
Associate Editor, Engineering News-Record

OHIO is undertaking a large program of road widening. Last year about 200 miles of state road was widened by adding from a minimum of 4 ft. to, in cases, equal the present width. The special cases of doubling the width are limited to a few main thoroughfares and partake more nearly of road rebuilding than of widening a narrow road. The essentially significant operations are those of reconverting old 16-ft. roads into 20-ft. roads. This includes resurfacing as well as widening. The roads being widened to two 10-ft. lanes are generally of macadam types; the widening from two to four lanes generally involves resurfacing old rigid pavements with two additional lanes of new rigid pavement.

Two types of widening are employed, water-bound macadam and concrete. The resurfacing is over the macadam widening strip but not over the concrete. Where old rigid pavements are being widened by one or two additional traffic lanes the widening is concrete. Old narrow macadam roads are usually widened with macadam but occasionally with concrete. Resurfacing is always with bituminous concrete or bituminous macadam. Fig. 3 gives sections of the several kinds of widened pavement as built in the actual operations.

The old macadam roads are generally 16 ft. wide, with high crowns of 3 in. or more. This calls for considerable haunch filling to bring the cross-section up to the flat profile of modern practice. Where the widening strip is concrete its top is at the level of and sloped to the finished profile; it thus forms a curb to hold the haunch filling and the new surface course. If the widening is macadam, its top is leveled to the old profile and the haunch filling and surfacing are carried over it. The depth of haunch filling varies with the original cross-profile, but the surface course is generally limited to a maximum depth of 2 in. and is 1 in. at the crown. Other details of structure and design are shown by the drawings in Fig. 3.

An example of multiple-lane widening is shown by Fig. 1. This is a section of the Cleveland-Buffalo road, which

Fig. 2—Finishing machine, tracking on new side slabs, resurfaces 18-ft. brick road to width of 20 ft.

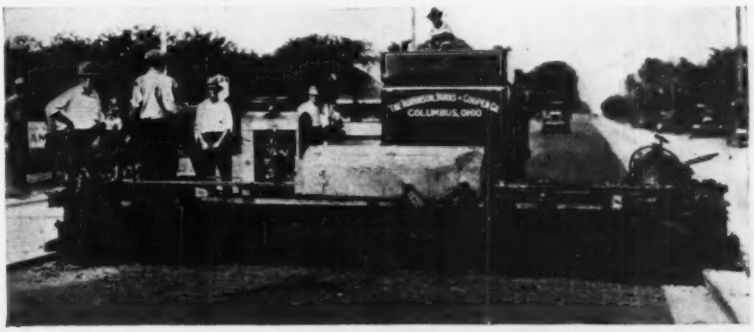


Fig. 1—Typical section of widened roads in Ohio.

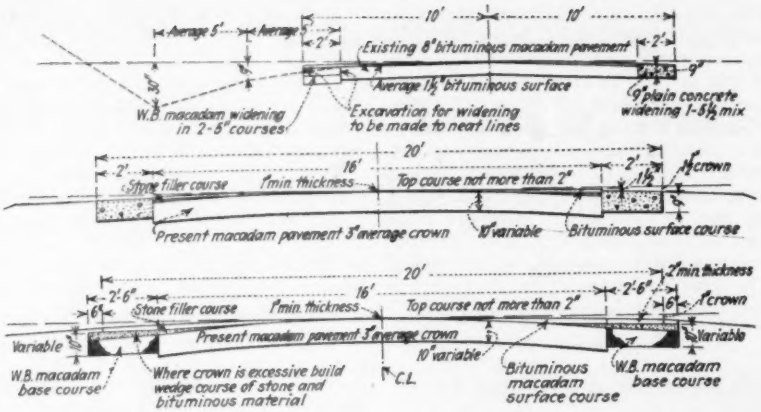


Fig. 3—Typical sections of widened road in Ohio.

originally was an 18-ft. brick pavement. It was widened by two 11-ft. concrete slabs with shoulders (Fig. 2) 1 ft. outside each edge of the brick to permit a 20-ft. bituminous concrete resurfacing course on the brick. The new road therefore has a 20-ft. center pavement of bituminous concrete and two 10-ft. side slabs of concrete. In general, multiple-lane widening of main-road rigid pavement is of similar dual type, although dimensions differ.

Fig. 4—Trenching scarified shoulders for macadam widening strips.

Fig. 5—Resurfacing half-width at a time, using spreader boxes with hot-mix trucks.

Fig. 6—Rolling hot-mix surfacing behind finishing machine.

The requirements for materials and workmanship are the same as for new construction. The macadam is normal water-bound construction, well compacted and bonded into the edges of the old road. Generally it is laid in two courses so as to insure a dense, solidly founded base, well knitted into the old macadam so that there will be no settling or breaking away at the junction to cause a crack or ridge in the surface course. This detail, it has been found, has to be made a particular care, and it is closely supervised. The concrete widening involves a little less religious care in jointing, as it forms a curb for and is not covered with the surfacing. The standard concrete paving mixture and workmanship are required, and transverse contraction joints are formed every 20 ft.

The bituminous-concrete resurfacing course is like the concrete, a standard mixture of the state highway specifications. It is plant-mixed and is a coarse graded material of about the following percentage compositions:

Sieve	Per Cent
Pass 1½ in. on ½ in.	40 to 60
Pass ½ in. on ¼ in.	10 to 20
Pass ¼ in. on No. 10	5 to 15
Pass No. 10	25 to 35
Bitumen	5 to 7

The bitumen has normally 40 to 50 penetration, but the pentration requirement is modified on different operations to adapt it to the particular kind of asphalt used and to traffic conditions. Temperatures, mixing and hauling methods correspond to usual good practice. In placing, the old surface is cleaned with particular care. Spreading and shaping has commonly been by hand methods, but on trunk-road operations finishing machines are used. A 10-ton roller is used, working in the usual way from side to center; the finished surface is required to show no variation exceeding ¼ in., using either a cross-templet or a 10-ft. straight-edge.

Construction methods

On all widening operations the grading and widening on one side of the road are finished and the finished half is open to traffic before work is begun on the second half. It is required also that work on the second half shall be started at the end where it was started on the first half. All work is planned to keep traffic moving. Besides detours for through traffic, the road under construction is required to be kept open for local traffic everywhere except the immediate place where surfacing is being laid. Particular injunctions are laid on the contractor to provide men to direct and maintain traffic 24 hours a day. So also where widening and surfacing are completed, the shoulders and berms have to be shaped neatly from the excess excavation.

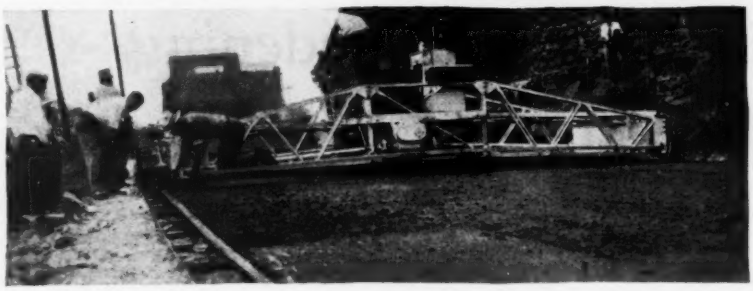


Fig. 7—Finishing machine working on bituminous resurfacing on widened macadam road.

Construction is carried on to the greatest practicable extent by machines. Figs. 4 to 7 show typical machine operations. The ditching of the shoulder for the base construction of the widening strip is shown by Fig. 4. Tractor-hauled scarifiers and blade graders make the excavation. Prior to the ditching, materials for the new base are piled along each side of the road, the base construction in two courses, using regular water-bound-macadam processes, then follows. Fig. 7 shows the placing of bituminous concrete surfacing, using a finishing machine. Where this is used, steel side forms set accurately and solidly to grade are required. Commonly the hot-material trucks use spreader boxes, as shown by Fig. 5. This illustration also shows a surfacing laid half at a time. Fig. 6 shows the surfacing being rolled.

Widening is being carried on as a major task of state system improvement, under the direction of the state department of public works, of which O. W. Merrell is director and H. P. Chapman chief engineer.

Tunkhannock Viaduct— Report on 17 Years' Service

Thorough examination discloses perfect concrete, marred only by contraction cracks in the parapet and discoloration from floor drainage blown against the piers

By M. Hirschthal
Concrete Engineer, Delaware, Lackawanna & Western R.R., Hoboken, N. J.

A STRUCTURE that has the distinction of being the most prominent or largest of its kind receives special and at the same time critical attention from engineers. The Tunkhannock Viaduct of the Lackawanna R.R. for many years has had this prominence. As the largest concrete railroad bridge in the world it has been subject to close scrutiny by railroad engineers both of this country and those visiting us from abroad.

While concrete is thoroughly established, there is still a tendency to magnify the slightest defects in concrete structures and broadcast the facts. In the case of the Tunkhannock Viaduct, rumors have cropped up periodically to the effect that something or other had gone wrong, usually resulting in a hurry call by the chief engineer for a careful inspection, in the last few years on three different occasions. The following result of a recent thorough inspection of the viaduct gives new evidence of the enduring quality of well-made concrete and should dispose of all rumors of the kind mentioned.

The Structure—To recall the structure in a few words: Tunkhannock Viaduct is located in the town of Nicholson, Pa., on the cut-off line between Scranton and Binghamton constructed by the Lackawanna R.R. in 1912-15. It consists of ten semicircular 180-ft. spans constructed in two 14-ft. ribs surmounted by open-spandrel construction carrying a solid concrete deck for two ballasted tracks. These spans are flanked by a 100-ft. semicircular abutment span at either end completely buried in the stone fill of the approach embankments. The total length of the concrete structure is 2,375 ft., the maximum height of top of parapet above Tunkhannock Creek is 240 ft., and above rock foundation is 300 ft. All of the piers as well as the abutments of the end spans are founded on rock, the deepest extending 100 ft. below ground. Construction began in 1912, and the concrete work was practically complete by the end of 1914, so that it is seventeen years old.

Condition found excellent

The recent inspection showed that in general the structure's 165,000 cu.yd. of concrete is in perfect condition. The views Figs. 1 and 2 are typical. Very few spots mar this perfect condition, and these are concentrated in two locations; both are clearly accounted for by faults of construction, neither is in the slightest degree serious, and one had been corrected in a portion of the structure at the time of building.

Parapet Expansion—The latter defect consists of cracks in the parapets at the refuge bays over each pier, where trackworkers park their handcars or speeders out of the way of passing freight or passenger trains (Fig. 5). These cracks are due to the sudden change of section and the square corners at the bays, and to inadequate provision for expansion of the parapet between piers. After the cracks formed they were filled with elastic asphaltic filler, whose black color emphasizes the cracks and makes them unsightly but which at the same time protects them against entrance of water.

As a matter of fact the inadequacy of expansion provision in the parapet had been discovered before the completion

Fig. 1—At second pier from east end; Arch and pier are fully preserved. The pier is disfigured by staining due to drip from oily roadway drainage.

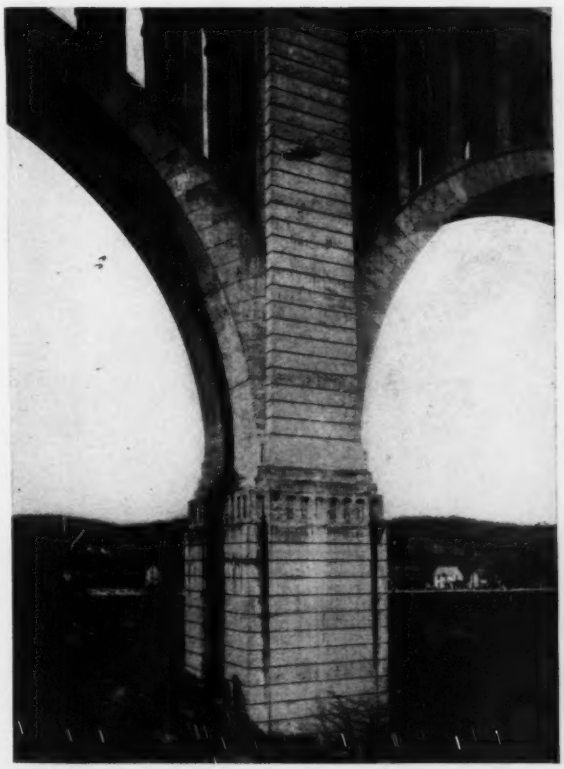


Fig. 2—The arch-rib concrete, seen from near the east abutment, is free from weathering, a condition typical of the structure as a whole.

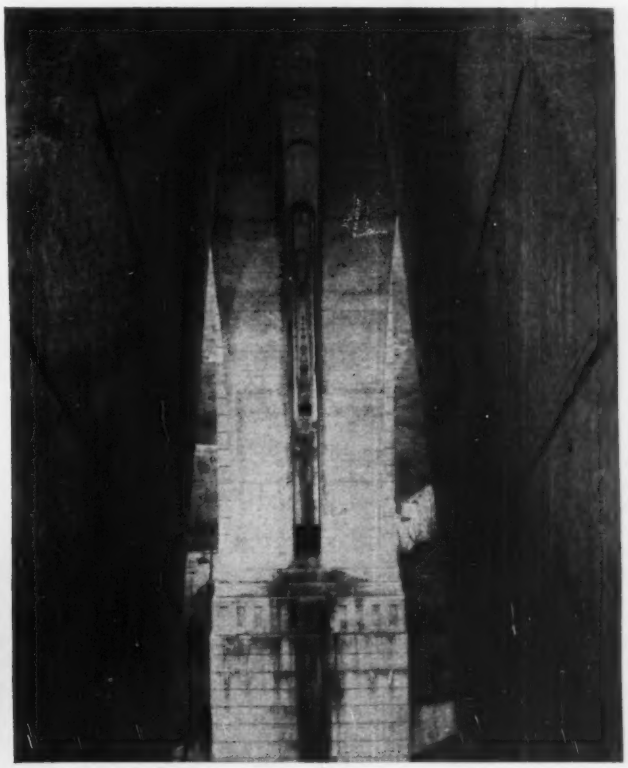


Fig. 3—Tunkhannock Viaduct, one of the largest concrete structures ever built, after seventeen years of service is found to be in substantially perfect condition.

Fig. 4—Form marks show plainly on the face of the sound parapet concrete, but a local spall has been produced by an embedded piece of wood.

of the structure, and in several spans the parapet was poured with intermediate expansion joints including elastic filler material.

Drain-Pipe Discharge — The other point is at the pier tops and sides between the arch ribs, at the springing of the arches, where the water from the drains located at the various spandrel walls had been blown by the severe winds almost continuously present in this valley. The designers did not foresee that the discharge from these drains, which are situated 20, 35, 65 and 80 ft. from the piers, would not drop down into the valley below but would be deflected by the winds to the piers. The effect is in no way serious, and but for its unsightly appearance (due to the presence of oil and creosote in the drainage water) would be negligible. The only concrete that is attacked by the discoloration is mere ornamentation on top of what was used as a centering ledge during construction for the forms of the arch ribs.

There is but one spot on the surface of the structure where a defect appears that is not traceable to the two causes above. This is where a piece of wood form inadvertently had been left in the parapet (inside face). Here the successive cycles of atmospheric wetting and drying, freezing and thawing have caused the concrete to spall (Fig. 4).

Reasons for good condition

Aside from these local and trivial defects, then, the viaduct is in substantially perfect condition. The accompanying views all testify to this fact.

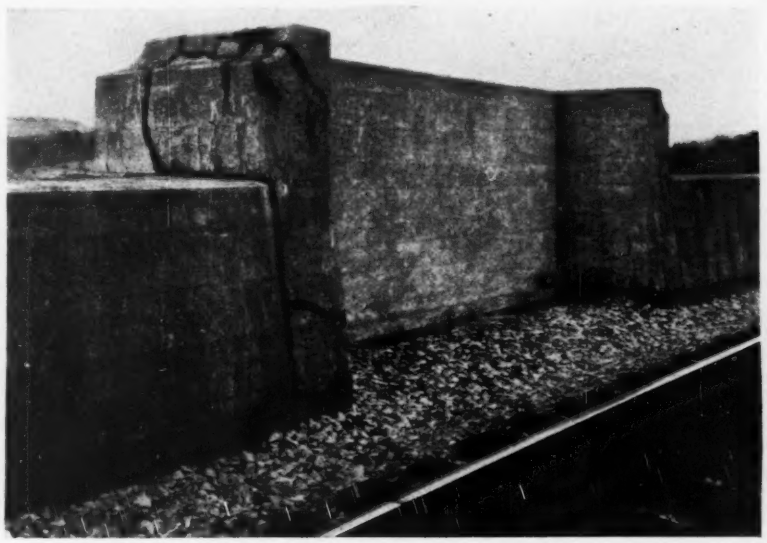
The splendid condition of the Tunkhannock Viaduct after seventeen years of service under severe climatic exposure could not be simple accident of construction in a structure of this magnitude. The service has been sufficiently long to test the durability of the material as well as the adequacy of design and construction.

The reasons for this excellent condition may be summarized by recounting the following carefully planned and well executed details of construction.

Deck Joints and Waterproofing—The concrete deck was provided with expansion joints at each side of the piers and near the quarter points of the spans (Fig. 6). It was pitched away from these joints and toward drains placed at the crosswalls between the arch ribs. The drains are of ample size (6 in.), and are surmounted by cast-iron screened drain boxes to protect against clogging and freezing. At each expansion joint the concrete was carried up well above the deck on either side of the joint to form a dam, further insuring against the entrance of water into these joints. The whole deck was waterproofed with three-ply asphalt-saturated cloth membrane laid in asphalt completely across the floor system and carried into and over the various expansion joints, and this membrane was protected from the ballast by asphaltic mastic which was carried over the dams at the expansion joints and up the sides of the parapets to the elevation of base of rail.

These details of expansion joints and waterproofing, and in connection with the latter proper drainage, are of utmost importance in the design of concrete viaducts. A concrete structure whose waterproofing is defective or whose expansion has not adequately been provided for defeats the aim of its selection,

Fig. 5—The walls of the refuge bays over the piers have cracked in many cases because of insufficient expansion provision. Some crazing is noticeable here; other parts of the structure are free from crazing.



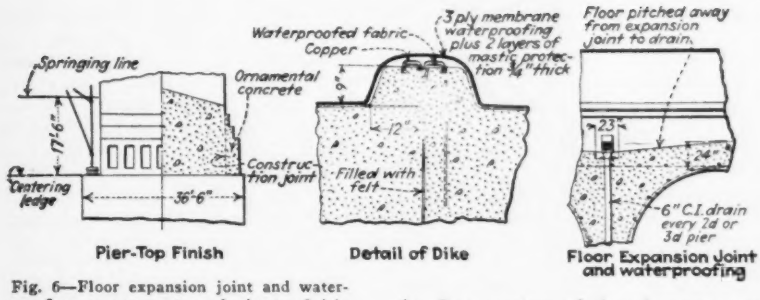


Fig. 6—Floor expansion joint and waterproofing arrangements, and pier-top finish.

since it requires expenditure for maintenance because of damage from leaks.

Good Mixing, Placing and Curing—Another and very important reason for the integrity of the structure lies in the materials and manufacture of the concrete itself. A 1:2:4 mix was used for the floor system of the abutment spans and 1:3:5 mix for the remainder of the structure (with derrick stone in the piers below springing line to form cyclopean concrete). The coarse aggregate was sound, broken limestone from Syracuse; the sand was Hodgson sand from Netcong, N. J. A standard brand of portland cement was used.

Despite the lack of modern methods of job control, the ingredients—together with water at what would now be termed a low water-cement ratio — were thoroughly mixed, with ample time allowance for that purpose, and in the forms the concrete was well worked by rodding and tamping. Proper curing at all seasons was assured by meticulously careful supervision.

The credit for these conditions should be given to the interested general direction of the work on the part of G. J. Ray, who was then and still is chief engineer of the railroad; the careful supervision of F. L. Wheaton, then engineer of construction, now retired; and of C. W. Simpson, then resident engineer, as well as the conscientious work of the general contractors, Flickwir & Bush, associated with F. M. Talbot, of the Talbot Construction Co.

Problems in the Distribution of Aggregates

With their market areas limited, the aggregate industries have developed intense competition, due both to technological changes and to deficient knowledge of costs—Some constructive suggestions

By O. Fred Rost

Marketing Editor The Business Week, New York

AS THE RESULT of a general study of how materials of construction are distributed, the author has written a series of articles, of which the following is the fourth. Problems of distribution as a whole were reviewed Sept. 10, 1931, p. 400. Conditions in the brick industry were discussed in two articles, Sept. 17, p. 441, and Oct. 1, p. 536. Essentially different troubles affect the aggregate field, as the present article develops. Study of markets and marketing methods, however, is again of prime importance in reducing losses and wastes. —EDITOR.

MARKED physical differences distinguish the various aggregates used in civil engineering construction — sand, gravel, crushed stone and related materials. Engineers might justly object to considering them as a group when discussing their functional characteristics and practical value. For the present purpose of analyzing their distribution, however, they may be thought of simply as aggregates, since all exhibit closely similar practices and and are subject to the same trends and problems.

The differences between different aggregates were not ignored in the surveys upon which the present observations are based, it is fair to state. Producers of sand, gravel and crushed stone were approached separately, with requests for specific information on specific phases of the process of distribution of their particular product in their particular territory. Futher, the field suvey that followed the process of gathering more or less statistical data covered not merely numerous plants producing aggregates but rather plants producing the different types of aggregates in various parts of the country.

Thus, for instance, the observations on the distribution of sand and gravel are a composite of facts and figures gathered from plants near the eastern slope of the Rocky Mountains, in the valleys of the Mississippi, Illinois, Ohio, Delaware, Hudson and Connecticut rivers, and in the region of the Great Lakes. Distribution of crushed stone was similarly studied in a geographical range wide enough to give a good cross-section of practice.

Because of the fact that these separately conducted investigations disclosed distribution trends, current ailments and prevailing practices far more closely similar than the materials themselves, it was considered unwise to attempt separate treatment of each group. The present article on the distribution of aggregates as a class is the result.

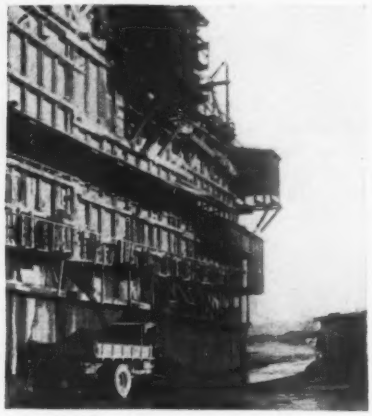
The importance of sand and gravel production as an industry can be gaged by the latest figures of the Bureau of the Census, covering the year 1929. A total of 1,152 establishments reported 19,628 employees, $33,117,264 in payrolls, expenditures of $20,239,598 for fuel, electric current and supplies. Their output of 168,761,960 short tons was valued at $104,241,724 f.o.b. plant.

From the same source we learn that this huge tonnage of bulky material, averaging only 61c. per ton in value, was distributed to various purchasers as follows:

	Per Cent
To contractors for government construction of highways, streets, bridges	15.7
To contractors for private construction	15.6
To wholesalers and jobbers	9.9
For miscellaneous federal, state and municipal construction	9.8
To contractors for other than government construction of highways, streets, etc.	8.8
To railroads for ballast	8.3
To affiliated companies	4.4
Direct sales for general construction	3.2
To contractors for government construction of buildings, etc.	1.8
To affiliated ready-mix and other plants	1.8
To commission agents and brokers	1.6
To non-affiliated ready-mix and other plants	1.5
To public utilities (not railroads)	1.5
To railroads (for construction, not ballast)	1.5
Commission sales	0.9
Unclassified	14.3
	100

It will be noted that of the classified 85.7 per cent of total output, all but 11.5 per cent of the sales were made direct to the user, this 11.5 per cent covering sales to wholesalers, jobbers or on a commission basis. In other words, the building-supply dealer is only a small factor in the industry.

With the great bulk of its output going in a straight line from the producer to the consumer, the industry as such can have few of the ordinary distribution problems. Instead the problems disclosed by the survey, while in themselves in the field of distribution, actu-



Where the problem of distributing aggregate begins: A production plant for gravel and sand. Material is screened and washed. Trucks load directly from the washer.

ally have their origin in the peculiarity of the product.

Sand and gravel, the products of geological processes, are found in various types in varying quantities, at many points. (According to the 1929 census, nine states consumed 108,751,000 tons, or 64.4 per cent of the country's total reported tonnage and 62 per cent of the total dollar volume. These large consumers are California, Illinois, Indiana, Michigan, New York, Ohio, Pennsylvania, Texas and Wisconsin. The other 39 states consumed only 38 per cent of the output.)

Effect of technical evolution

For many years sand and gravel were sold on a run-of-the-bank basis. As concrete grew in importance, research and experience improved the knowledge and technique of how to mix concrete to obtain best results. Engineers developed definite preferences for certain sizes or types of sand and gravel in connection with certain types of concrete construction. Rapid growth in the use of cement was naturally paralleled by a corresponding growth in "consumption" of sand and gravel. Operators of the larger banks installed machinery for digging, screening and loading. As engineers began to demand washed sand as insurance against failure of concrete construction, washing equipment was added.

Sand and gravel "producers" thus became processers, and some of the large plants found themselves with a considerable investment in machinery. This fact in turn brought the need for greater volume to insure satisfactory returns on capital and created highly competitive conditions, particularly in those areas where important construction work was in progress. More recently the competitive situation has been aggravated by decline in construction activities and drastic reduction in demand.

Today the sand and gravel industry, finding its product in almost limitless quantities right at hand, justifiedly complains of over-capacity. While in a few sections operators reported 1931 output up to capacity, some concerns turned out less than 50 per cent of a five-year average. A group of operators located at widely separated points, reporting annual output capacities ranging from 200,000 to 3,000,000 tons, sold in 1930 what amounted to 74 per cent of their capacity. With isolated exceptions, consumption for 1931 averaged nearer 60 per cent of capacity.

As has been the case in other industries, excessive productive capacity invited destructive competition, which in turn brought the problem of how to operate at a profit.

Competition now very active

Competition in this field is naturally limited to a very small territory, particularly when compared with those industries that have products enjoying regional or even national distribution. Concerns competing with each other are located not far apart, generally operate under similar conditions, frequently use the same mechanical equipment and pay the same rates for labor, and all produce under substantially identical conditions in that they all literally dig their basic product right out of the sandbank.

Thus the very nature of the industry's product has restricted the opportunity for development of any wide differences of production costs, such as in other industries, frequently form the basis of legitimate competition. For that reason, in some territories the selling prices of sand and gravel at the bank or out of the hopper of the washing plant are identical. But with the beginning of the actual physical process of distribution begins also much of the active competition.

This sand-and-gravel producer operates a ready-mix concrete plant. Conveyors carry the material direct from washer to mixing hopper.

Transportation a key factor

Transportation has always been an important factor in the final on-the-job cost of sand and gravel. In the days when all but a negligible percentage of the product was shipped by rail, freight charges per ton frequently were several times the actual value of the material. The steady improvements in motor trucks, their increased reliability, greater speed and greater flexibility have brought about a rapid increase in their use in the sand and gravel field, so that railroad freight shipments represent a steadily diminishing percentage of the total output.

In the year 1929, when, according to the U. S. Bureau of Mines, the country's production of sand and gravel exceeded that of 1926 by 40,000,000 tons, the tonnage hauled by railroads was actually less than in 1926. There are many plants that today are making no more shipments by railroad freight, while the figures reported by others show that truck shipments are increasing at an enormous rate. Some plants located on navigable waters do of course employ the cheaper water transportation wherever possible, but motor-truck delivery is naturally employed for the final delivery to the job, except where ready-mix plants take the gravel direct from the barge into the mixing hopper.

The requirements of road or bridge building or other major construction activities are of course still covered to a considerable extent by railway freight shipments where a sand or gravel supply is not available within trucking radius, but even then in many instances trucks must be employed for delivery from the siding to the job.

Since trucking has become an almost indispensable link in the distribution of sand and gravel, and since the cost of motor trucking represents a more variable and less definite factor, it is only natural that many of the competitive battles of this industry have been fought not on price of the product but on cost of distribution.

Those operators who maintain their own trucking equipment generally have a fair idea of ton-mile costs of trucking and do not readily quote prices that will mean unpaid-for wear and tear on equipment and a loss on total operations.

One or two operators of important plants owning their trucking equipment definitely stated that unless they can make a profit on the trucking as well as on the product they prefer not to handle the business. Such policy is successful where no competitor operates in the immediate territory, but might lead to serious loss even under normal competitive conditions.

Sharp competition in trucking

The handling and transporting of construction materials has become a regular business in many territories. Sometimes a man merely owns and operates the truck that he himself drives. In many cases out of just such beginnings and frequently with the aid of truck manufacturers and finance companies, there will grow a fleet operation covering many trucks. While business was good these truckmen had definite rates that were based on loading conditions, mileage and road conditions, terrain and method of delivery, and were so adjusted as to provide for operating costs, depreciation charges and a profit. Under present conditions these truckmen are chiefly interested in getting enough work to keep up instalment payments and living expenses.

Wherever there is a job of hauling certain quantities of building materials there generally is a war for the trucking business. Rates that were found to have ranged formerly up to 25c. per ton-mile frequently go down to 5c. per ton-mile. Certain hauls from plant to neighboring cities that three years ago were made at $2 per ton now find ready takers at 50c. Frequently these truckmen will get a job on the basis of cut-price trucking, and then will shop around at various plants in an effort to buy the material at lower costs, sometimes entirely disregarding the extra mileage involved when they can get a cut price from a plant located considerable distance away.

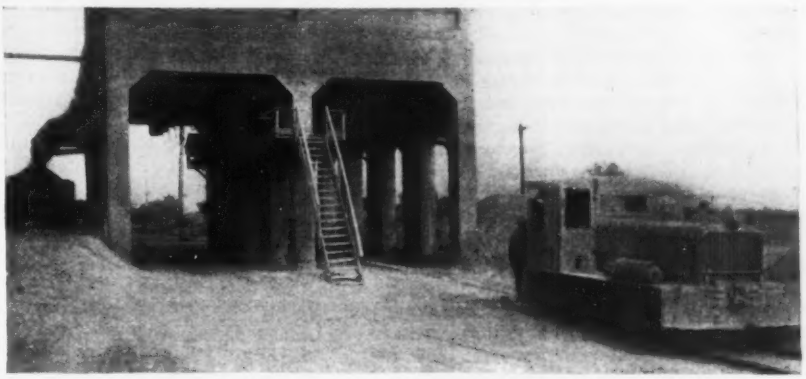
Naturally these competitive conditions are more or less temporary. To offset this disturbing and irregular competition, one large plant, operated under exceptionally efficient management, has for the last two years operated its own fleet of trucks, and thereby has obtained a much more uniform flow of business than was possible while truckmen's competition prevailed. For city delivery under normal conditions of dumping the load, this company has a flat delivery rate per ton depending on which section of the city is concerned. For delivery beyond a 10-mile radius a charge of 8c. per yard-mile is made, and this schedule has shown a profit on the trucking operation.

Trucking controls logical radius

It is obvious that producers of sand and gravel are not in position, due to the heavy cost of transportation, to promote the sale of their product much beyond the current demands for construction work in their logical trading area. Therefore, it is only natural that some have made efforts to build profits in allied lines. Several able operators have succeeded in maintaining profitable sales volume in their sand and gravel operation by establishing plants to supply ready-mixed concrete. One Western city played into the hand of certain sand and gravel producers when it passed an ordinance prohibiting the mixing of concrete in the business section, and since then the ready-mix plants started by them have done well. A large producer in New York State now concentrates all sales effort on the product of his ready-mix plant, and although less than three years old, this ready-mix plant will in 1931 account for nearly 50 per cent of the total sand and gravel output by the parent concern.

Another sand and gravel concern has started a plant for making concrete-pipe culverts and fence posts. Its sales have grown rapidly, due to the fact that close contact maintained with the state highway department has enabled the company to anticipate requirements. Being well financed it was able to build up a stock of needed items, so as to have them properly seasoned and ready for spot delivery when wanted.

The field survey disclosed one able owner of a large sand and gravel plant who has found a unique way to bridge over the depression. He closed down all machine operations, put his trucks in dead storage and is selling only run-of-the-bank material *at the plant* until increased demand makes it profitable to resume complete operations. Meanwhile he has started to manufacture a line of concrete garden furniture, vases, benches, bird baths, etc. He maintains a roadside display along a near-by highway and reports doing a good business with motorists, most of it on a cash-and-carry basis.



Truck and rail compete at the bin hoppers of this crushed-stone plant.

Some conclusions and suggestions

The foregoing covers in substance those outstanding practices, characteristics and peculiarities in the distribution of sand and gravel that today prevail in the industry and should prove of general interest. Terms and prices vary so greatly as to make it impossible to present any general conclusions.

The following more specific observations are submitted as of interest chiefly to those directly or indirectly engaged in the industry:

1. Distribution processes of the sand and gravel industry are definitely limited by the high weight and low cost of the product.

2. The increasing use of motor trucks in the physical distribution of the product has clearly contributed to the unsatisfactory competitive conditions that exist in some territories.

3. Research into the actual costs of motor-truck operation in the hauling of sand and gravel and proper publication of the results of such studies might help to improve conditions. Many operators of plants as well as trucking contractors are earnestly striving to sell and haul at a profit but have insufficient knowledge of ton-mile costs.

4. The fact that the demands of engineers have become more exacting and have necessitated heavy investments in machinery has served to keep smaller operators who were unable to make such investments out of competition on large jobs.

5. The fact that states and cities are establishing limitations or more rigid rules on the use of sand and gravel for concrete should eventually prove beneficial to the industry as a whole if the constructive influence of such regulations is effectively capitalized.

6. For large government, state or municipal construction jobs the industry itself should establish definite engineering standards and, if necessary, create a testing or policing service while such jobs are in progress, so as to prevent unsatisfactory results or failures. In one state, now engaged in an important building program, use of certain sand and gravel for state work has been

banned because trouble with scaling of road concrete was experienced in one section. Industry supervision to insure maintenance of standards could probably have avoided this.

7. Government, state and municipal legislation govering the proper uses of sand and gravel should be encouraged; standard forms of specifications and ordinances should be promoted.

8. In concrete work, as a measure of public safety, attempt should be made to prohibit the use of unwashed run-of-the-bank material within all incorporated communities.

9. Research should be supported by the industry to discover new uses or byproducts that operators can reasonably manufacture.

Crushed-stone practice similar

Due chiefly to the similarity of basic characteristics of the products involved, the practices and problems of distribution in the crushed-stone industry are to a considerable extent identical with those found in the sand and gravel field. However, since the production of crushed stone involved more substantial investments and the mastery of more serious problems of engineering and management than were demanded from the original gravel-bank operators, the crushed-stone industry has from its inception attracted on the average a different type of executive talent. This naturally has been reflected in the manner with which the industry has organized itself for the distribution of its product.

Crushed-stone producers, having always had definite factors of cost to consider in connection with production, have tended to give more thought also to distribution costs, and therefore have been less inclined to engage in destructive practices of competition, although in some territories price wars have sometimes carried selling prices below actual cost of production. Among those who were operating their own motor trucks were found several with remarkably complete records of operating costs. Being actually manufacturers of their product, rather than having merely the problem of screening and washing, crushed-stone operators as a class maintain more complete records, obviously necessary for most efficient operation and particularly important where climatic conditions prevent operation during part of the season.

It is particularly interesting to note that motor-truck delivery has in this field also replaced rail shipments to a considerable extent. Definite figures on this subject were submitted to the author by a number of concerns, but permission for publication could be obtained in only one instance. This case represents the experience of one of the largest operating units in the field, which ten years ago shipped exclusively by rail, although a small percentage was later dumped on barges for water delivery to a distant city. For 1930 the shipments from this plant went forward as follows:

	Per Cent
By rail, for use as ballast	20
By rail for commercial uses within a radius of 50 miles	20
By motor truck for reloading on barges	10
By motor truck for on-the-job delivery within a radius of 30 miles	50
	100

Ten years ago one crushed-stone plant located near a large city shipped all its output by rail; now all but 5 per cent goes by motor truck.

The sales of crushed stone are handled in several different ways. Some plants maintain a regular sales department. In some territories so-called sales agents have agreements for the entire output of several plants and function on a commission basis. Because of the fact that crushed-stone plants are less numerous than sand and gravel banks, the building-supply dealer is a more important factor in its distribution.

A special survey, including a number of plants located in widely separated parts of the country, with capacities ranging up to 500,000 tons per month, shows the following distribution of sales:

	Per Cent
Direct to municipal, state or federal governments	28
Direct to other users, railroads or contractors	19
Total direct selling	— 47
To retail building-supply dealers	28
Through salesmen or agents	20
To wholesalers for stock	5
Total indirect selling	— 53
	100

Operators who are anxious to improve general conditions in the industry claim that a number of its problems can be solved or lessened by cooperative action, cooperatively supported.

Improving stone distribution

Among a number of subjects mentioned as being susceptible to group action the following appear worth recording:

1. Standardization of sizes and means to effect adherence to such standards.

2. Research to establish the most definite records of the efficiency of the product in actual use, so as to provide a basis for more rigid engineering standards and more ethical sales methods.

Crusher unit of a stone plant, with discharge to stock piles farther down the mountain slope.

3. Research to develop new uses.

4. Uniform methods of cost-accounting covering production, and more particularly those costs of distribution that definitely affect the ultimate price of the product paid by the consumer or user.

5. Market studies to determine potential demand in specific territories and intelligent cultivation of markets.

The situation summarized

Substantially, most of the producers of aggregates are genuinely awake to their problems but have been induced to address themselves to the task of finding a solution only as scarcity of business, a discouraging outlook or a sustained period of depression forced them into action. Concerns that are efficiently managed and well financed have fared rather well. By organized selling, by establishing ready-mix plants or by creating an alliance with one or more ready-mix operators, they have maintained their sales volume and earning power.

Research can contribute both to the development of products and to the broadening of markets. Profitable selling by individual operators is best assured when the extent of available markets is known and understood.

Crushing of Culverts Under Rockfill

That rockfill over a culvert acts in much the same way as earthfill and does not arch over the structure, as is sometimes assumed, is a conclusion based upon tests of three 36-in. cast-iron culverts in a rock embankment built by the Iowa highway commission. In these tests, as reported by M. G. Spangler in Bulletin 104, of Iowa State College, two of the culverts failed structurally because of being overloaded. Within twenty months the number of cracked sections in one culvert increased from five to sixteen, indicating an increasing load. This information supplements an article on the culverts and tests, by Mr. Spangler (*ENR*, June 5, 1930, p. 931).

Education in Fundamentals Finds Wide Support

Teachers and licensing authorities join Dean Kimball in opposing trends toward specialization

IN A SEARCHING DISCUSSION of what engineering education should accomplish and what methods it should use, Dean Dexter S. Kimball, of the College of Engineering of Cornell University, in our issue of Dec. 17, 1931, made a strong plea for the fundamental studies. He rested the appraisal of engineering education on "the depth and solidity of the basic studies." Because of the prominence of the subject the editor invited expressions of opinion from some well-known teachers and from engineers in close contact with registration. Their views, presented below, are a significant expression of present-day opinion.

—EDITOR.

Fundamental Subjects Develop Adaptability

By Dean C. C. Williams
University of Iowa, Iowa City

DEAN KIMBALL, in his usual cogent style, has reviewed the case of fundamentals vs. specialization. Educators will generally agree with his emphasis on fundamentals because of their belief that the function of engineering education lies in developing the innate powers of their students rather than in teaching them craftsmanship, however skilled. In this view educators have the interests of their students and ultimately of society primarily at heart.

Assuming the objective of education to be attained if students through life find themselves able to meet successfully the conditions with which they may be confronted, the nature of those conditions becomes a consideration. Even a casual observation reveals the dominant characteristic of those conditions in the past to have been *change*, a characteristic destined to be even more controlling in the future. Engineers who have been able to prosper in this kaleidoscopic situation are those with sufficient versatility and adaptability to be able to shift with the times; and these qualities, in so far as education confers them, are derived from proficiency in fundamentals that do not change, rather than from a knowledge of the passing practice described in the examples in college textbooks.

A certain amount of applicatory matter is advantageous in college courses for motivation and vividness, and the manner of teaching this material is highly important. In fact, much of the training in the analysis and the synthesis that constitute engineering clusters about practical examples. The purpose of such examples should be fully understood, however, to be mental training rather than mental storing. As instrumentalities for training, they are of direct and permanent value; as stored information, they are ephemeral and futile.

The abiding elements of technical education are the ability to observe accurately, to think clearly, and to express ones thoughts adequately, together with proper standards of workmanship and an inspiration to achieve. Whatever instruction, problems and laboratory tests may be employed in the educational process are merely exercises to develop these essential elements; the specific information involved, beyond thoroughness in the fundamentals of physical science, is of secondary importance.

* * *

Present Courses Best

By Dean Milo S. Ketchum
University of Illinois, Urbana

IN THE writer's judgment no system of education serves its purpose unless it trains the student to think and to do and unless it gives him power to perform. The engineering student is not a bottle to be filled with information or a sponge to sop up culture, but is a growing entity that must learn to find himself, learn how to attack a problem, and also acquire some appreciation of what may be expected of the practicing engineer. There has, in my judgment, not yet been a better plan proposed than the present four-year curriculum in applied science for all engineering students, followed by graduate work in engineering for those graduates who have shown aptitude for study and who have a desire to get a better preparation for the practice of engineering.

Many have assumed that, because successful engineers are cultured gentlemen, the best system of education for engineers is one that will best contribute to making the graduate a cultured gentleman. This erroneous and absurd point of view has been given wider circulation by the results of the questionnaire sent out by Dr. C. R. Mann, director of the first study of engineering education, referred to by Dean Kimball. The questionnaire was on a ballot postcard giving six groups of qualities, which were headed: (1) character, (2) judgment, (3) efficiency, (4) understanding of men, (5) knowledge of fundamentals of engineering, and (6) engineering technique. Each voter was requested to prefix numbers to each group to show his estimate of the relative importance of the quality to an engineer. The conclusions drawn from the replies received were that the first four qualities represent 87 per cent of those qualities that were most essential for the success of the engineer, while the last two qualities, which constitute a large part of the normal curriculum, represent only 13 per cent. The six qualities covered by this questionnaire are excellent ones to use in making an estimate of the present worth or value of an engineer, but, as in the case of the valuation of a public utility, all the qualities must be given consideration, and the final estimate of present worth of the engineer must be a judgment arrived at after a study of all elements of value.

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Educate Men With Capacity to Become Engineers

By Dean A. A. Potter
Purdue University, Lafayette, Ind.

DEAN DEXTER S. KIMBALL has clearly indicated that there is very little specialization in the engineering curricula of the colleges of today. Experience indicates that broad and thorough education will enable the college graduate to reach greater usefulness in his profession than will specialized technical training. A summary of enrollments in 145 engineering schools in the United States in 1930-31, as reported in the Journal of Engineering Education of September, 1931, indicates that out of a total of 78,685 engineering students, 59,877 (76 per cent) are enrolled in the four major curricula of chemical, civil, electrical and mechanical engineering.

The interest of engineering colleges has hitherto centered in undergraduate instruction. An effort has been made to train the student for largest ultimate development and for greatest usefulness in the long run. The engineering colleges have not attempted to turn out a finished product but to graduate *men with capacity to become engineers.* They have trained students in the rational solution of problems by building the engineering curricula upon a mathematical and scientific foundation. Mathematics, science, mechanics and the fundamentals of engineering were used to develop reasoning power and the ability to arrive at truth by observation and by experiment. The importance of facts and the responsibility of the engineer for accurate results have been constantly stressed. Engineering educators have successfully warded off all attempts to lower the rigidity of the engineering courses of study and have concentrated on subjects that the student cannot well acquire by his own efforts or without hard work. The providing of a background of engi-

neering knowledge has always been subordinated to the training of the mind. The policy of engineering colleges has been to give an important place to studies that develop in students the ability to understand and to interpret correctly the ideas of others, as well as the capacity for clear logical thinking and clarity of expression on their own part.

Graduate instruction in engineering has received a new impetus in connection with the development of engineering experiment stations in colleges, but the number of students who will take advantage of post-graduate training will remain small until the industries and utilities come to appreciate the value of more thorough engineering education than is provided in the undergraduate engineering curricula. Industry has not made the engineering college, nor is the engineering college alone responsible for the progress in the material content of our civilization; the two are interdependent. Industry is dependent upon the engineering colleges for a supply of men who have a scientific and technological foundation and for leaders who have the training and talent to explore new fields. The engineering colleges are dependent upon industry to keep their instruction abreast of the times and their research activities practical and effective.

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Practical Men Confirm Value of Fundamentals

By Prof. R. M. Fox
University of Southern California, Los Angeles

DEAN KIMBALL struck a note in the issue of Dec. 17 that finds an echo in the heart of many an engineering teacher. Our experience at Southern California is doubtless similar to that at other metropolitan institutions. In the larger cities the nobility of the profession—those who do the big engineering things, and lots of them—not only fraternize at meat but discuss these very problems among themselves. One such body in Los Angeles permits faculty representatives to eat with them, and to enter into, and profit by, their conversations. We call them an Advisory Council, but they would be as frankly critical and as constructively helpful by another name. They also have come to Dean Kimball's conclusion that the emphasis in education should be on fundamentals. For, the permanent advancement of the individual graduate is initiated more often through his grasp of some fundamental than through accidental aptitude in a specialized field. One of these advisers attributes his start to his ability to factor for the solution of a sixth-degree equation. This skill is obviously more fundamental than, for instance, knowing the horizontal angle of the cuts in the chicle tree from which latex is extracted, however valuable that might be to Dean Kimball's gum engineer.

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Broad Activities Require Fundamental Training

By Prof. Thomas R. Lawson
Rensselaer Polytechnic Institute, Troy, N. Y.

EXAMINATION of the register of almost any engineering school will show that later in life only about 30 per cent of the engineering graduates follow the fields indicated by their degree. It is here that the advantage of the general education is apparent, since it enables the young graduate to pursue work in other fields with less of a handicap than he would otherwise have. It is not unusual to find engineers who become bankers, lawyers, physicians and presidents of corporations. Much of their success is due to the general nature of their fundamental training.

In order, then, to be of the greatest service, engineering schools might well give as much of the general engineering courses to their students as they can without encroaching upon the particular line of work chosen by the student. Cultural courses are of course highly desirable, and where possible they should be included. Where these courses interfere with the generalization of the engineering courses, there is grave question as to the desirability of their being included to any great extent, since their substance may be more easily acquired after graduation than are the fundamental engineering courses.

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False Arguments for Specialization

By Dean Arthur M. Greene, Jr.
Princeton University, Princeton

FEW of the successful men in engineering and industry remember the steps up which they came to their present position. In forgetting these steps these men remember merely the *additional study* that they had to give to some specialty; and thinking of this, they believe that the engineering school should include in its curriculum the work that they had to do after graduation. They do not realize the limited field of their specialty and remember that out of the thousands of graduates each year less than a score probably would be demanded by the division of engineering in which they are working. They fail to realize that the preparatory work that they received in the engineering school was really the training that made it possible for them to master the limited field of engineering, and that without their fundamental training the results of this special work would not have been possible in the time actually taken.

Engineering education is not only the work of the schools but it is also the work of the employer in giving to the graduate opportunity to obtain the further development of his fundamentals along special lines.

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Broader Curriculum With Less Rigid Requirements

By H. P. Hammond
S.P.E.E. Summer School, Brooklyn, N. Y.

DEAN KIMBALL hits a number of nails on the head in his article "Fundamentals or Specialization." No statement that has appeared for a long while is more accurate or a fairer appraisal of engineering education and its relationship to the profession. Written in Dean Kimball's vigorous style, it should carry conviction to many.

Lack of space has doubtless prevented Dean Kimball from mentioning that one of the most pronounced trends in engineering education in the past two decades has been a swing away from specialized courses in engineering technique toward better grounding in the fundamentals of engineering science. Much of the deadwood of 25 years ago has disappeared. The load on the student has been perceptibly lightened. The curriculum has been somewhat broadened.

Another striking trend is toward graduate study. It is perhaps not understood that there are enrolled in American colleges today graduate students to the number of one-third that of the graduating classes of last June. The movement toward a longer engineering training, extending over five or more years, seems to be coming about through a natural process of evolution. Further, it is perhaps just as well that the students who continue for advanced work are a naturally selected minority who can profit by it, the majority stepping off into practice at the end of their four years.

The engineering curriculum will undoubtedly continue to change, following rather than preceding industrial conditions. One change that the writer should like to see is a loosening up of our rather rigid requirements. We are in some danger of failing to see the woods for the trees, in our insistence upon the performance of day-to-day requirements. We hold the nose of the student pretty closely to the grindstone of his daily work. There are, of course, distinct values in the discipline of an engineering education, but we may overdo it.

If we could introduce, toward the end of the course, a larger proportion of

optional and elective subjects in science and technology, and in humanistics, we should probably prepare broader-gage men. The tendency is now in this direction, but it might very well be accelerated.

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Education Trend Is Toward Broadening Studies

By Dean R. L. Sackett
Pennsylvania State College, State College, Pa.

DEAN KIMBALL'S statement on engineering education is thoroughly sound and places several of the most important professional problems squarely before technical societies and engineers in general.

The engineering educator has given ear to the saner opinions of engineers concerning the improvement of curricula when the limitations of time and cost were considered. The survey by Dr. C. R. Mann called attention to the importance of personal qualities. Following that report, the S.P.E.E. investigation and closer cooperation with industry personnel methods have been in operation at an increasing number of engineering institutions.

Engineers are sometimes unaware of the changes in emphasis or content of college curricula that have taken place in recent years. The tendency toward specialization ceased, in general, several years ago. In fact, the movement is toward broadening. One still hears from practicing engineers the request to add something; but when you ask, "What would you omit?" to make room for a proposed subject, however desirable it may be, there comes a realization of two important questions: (1) is the proposed course more important than some one now given? and (2) is it desirable to load more heavily the engineering curricula that have always been so severe as to make it difficult to elect cultural courses?

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Fundamentals in School and Other Subjects Later

By A. B. McDaniel
Washington, D. C.

DURING my career as a preceptor, more than a decade ago, there was an increasing tendency toward specialization in most of the technical schools. This was during the period when the whole tendency was toward bigness, and I well recall when the slogan of one university president of one of our larger Middle-Western universities was, "Let us have the largest buildings and enrollment in the country." It was at this same university that a quarter of a million dollars was spent in the construction of a large building that was devoted entirely to the training of young men in various branches in the field of railroad engineering. It would be interesting to learn the cost per capita of educating the embryo engineers graduated from this particular department.

Needless to say, I am in hearty agreement with Dean Kimball relative to the importance of the training of our engineering students in the fundamentals. Almost any engineering graduate who has consistently followed the practice of his profession will testify that the facts he learned in school have long since been forgotten, and the success he has achieved has been largely due to the results of the training that prepared him to observe accurately, to reason logically and to act promptly and correctly.

* * *

Education and Registration Should Have Same Goal

By D. B. Steinman
President, National Council of State Boards of Engineering Examiners, New York City

IN THE WORDS of Dean Kimball: "Engineering is no longer an empirical calling but a scientific profession." This truth is recognized in the increasing emphasis on educational qualifications in engineers' licensing laws, in the recommended uniform registration law, and in the standards being developed by the National Council of State Boards of Engineering Examiners. The national engineering societies should now fall in line and should also adopt "more rigid educational requirements for membership."

Dean Kimball splendidly takes the stand for maintaining emphasis on the common fundamentals in engineering education as against any trend toward specialization. The object of engineering schools should be to turn out engineers, not specialists. As a parallel thesis, the object of registration should be to qualify engineers, not specialists.

The recent report of the National Council's committee on licensing examinations says: "To the extent that engineering is essentially a mode of thought based on a mastery of the laws of nature, the examinations should be basic and fundamental rather than specialized. . . . . The desired picture of a professional engineer, to be brought out by this plan of examination, is a man of high intellectual honesty, thoroughly trained in the common basic fundamentals underlying all engineering work, with some essential knowledge of the elements of all branches of engineering, and with additional specialized knowledge and training in one major branch of engineering. The better engineering schools have curricula designed to meet this specification."

Dean Kimball records the increasing recognition of the necessity of lengthening the period of college training for engineers. The four-year course may have been adequate two generations ago, but the increasing content of essential engineering knowledge and the growing recognition of the desirability of a background of liberal and cultural studies for a professional man have altered the picture. Those of us who took a complete college course before entering an engineering school have never regretted it. Whether the additional years should precede or follow the traditional four-year engineering course is a moot question. Personally, I favor a pre-engineering college course of two years, ultimately of four. This is in line with the best standards achieved in other professions.

The remaining topic in Dean Kimball's paper is the value of registration. While generally favoring licensing, he states that its possibilities are often overestimated. I am convinced that the engineers of this country have not begun to realize the possibilities of licensing as an effective means of raising the standards and the standing of the profession. And, what is more to the point in the present discussion, registration laws provide the means for strengthening educational standards by prescribing progressively higher educational qualifications.

* * *

Integrating Arts Subjects in Four-Year Engineering Course

By E. A. Wheatley
Registrar of the Engineering Profession in British Columbia, Vancouver

VERY LITTLE PROGRESS is made in the subject of engineering education, due to the lack of any precise definition of, or the use or application made of the words "cultural" or "liberal." Dean Kimball's article leaves the practicing engineer even worse confounded leading him to believe that the four-year course consists of fundamental engineering subjects in the first and second years, and that these subjects decrease in the third and fourth years, being replaced by cultural, liberalizing subjects. There is no doubt that this is contrary to the usual state of affairs.

The phraseology used by the Society for the Promotion of Engineering Education for the general four-year course is better: a course in which the first and second years consist of basic sciences, together with a modicum of arts or cultural subjects, English and history. These cultural subjects and the basic science subjects disappear in the third and fourth years, being replaced by specialized subjects suited to the branch of engineering selected.

The cry today is for the philosopher engineer or for the educated engineer, who is "familiar with the best literature in his own language and probably in that of one or two others; able to read many branches of learning understand-

ingly and to discuss them intelligently." Obviously, therefore, any improvement in the engineer's curriculum lies in languages, literature, history and philosophy. No additional sciences, and certainly no additional pseudo-sciences such as psychology, are needed. The words "cultural" or "liberal" subjects do not mean public speaking, accountancy or engineering economics.

If an extra year is contemplated, the year will be next to entirely wasted if such year is given to more sciences and more of these general subjects just enunciated. Further, the year will be very largely wasted if it is made a special year to deal with arts subjects, set apart from the four-year engineering period. A Canadian university that has a fifth year largely wastes the year by interposing it between high-school studies and the beginning of the engineering curriculum.

A year's program on strictly arts subjects, avoiding all sciences and mathematics, should be drawn up and then the content of this year's work spread over five years to form a continued and integral part of the ordinary engineering course. It is obvious, from a logical point of view, that this is the only way to improve the engineer's curriculum. It continues his high-school studies without any break, and it causes him to bring his most mature mind right up to the period of his graduation to these cultural subjects.

* * *

Make Good Engineers!

By Dean F. E. Turneaure
University of Wisconsin

PROFESSIONAL SUCCESS is so largely dependent upon the individual, the environment and the opportunity that, outside of the fundamentals that are generally agreed upon, other curriculum questions seem to be of minor importance. It is difficult to see in what way any one of the many and varied schemes that have been tried out in the past twenty years has proved to be particularly advantageous.

In our experience there is much less demand by alumni and practicing engineers for technical specialties than fifteen or twenty years ago; and we believe that the great majority of mature engineers interested in education are quite as strong for the fundamentals as are the members of faculties. After all, how much can we expect to influence the career of an engineer by means of a three- or four-hour course in economics, banking or accounting, taken at the time he is a student, when the time arrives, after perhaps ten years out of college, that he is called upon to assume some managerial position? Certainly not a great deal. The best we can do is to introduce him to these subjects, awaken his interest and perhaps teach him the elements of accounting practice as we teach him drawing or surveying.

The primary requirement of an engineer is that he shall be a good engineer, and in this regard we have reason to think that his reputation is thoroughly good, and quite as good as that of the members of other professions. It is fully expected that he will do a good honest job, whether for a private corporation, a state or municipality, or the Soviet government of Russia. Whatever we do in education, we must not weaken the fundamental training in engineering. We are all in favor of general culture for every professional man; and, so far as the engineering curriculum is concerned, it is our belief that the best arrangement is to provide opportunity for elective studies throughout the entire four-year course.

If an engineer expects to become a valued adviser along other than technical lines, he will have to post himself on the problems of the day as other people do. A little more or less work in college will have little or no effect. Our group of bankers, politicians and corporation managers numbers, undoubtedly, a very large number who have had a liberal education, including a considerable proportion of economics and similar studies that should be a good preparation for their work; but from present indications they do not seem to have done quite as good a job at their business as has the engineer. There is no denying that their job is probably more difficult; but in view of recent experiences, how much effect will it have on an engineer's capacity to carry on administrative work, to add to his college curriculum a three- or five- or ten-hour course in advanced engineering economics? Let him thoroughly learn the needed fundamentals of his own profession and prepare himself for whatever responsibilities may come his way by study in the field that he is called upon to occupy.

* * *

Four Years' Training Enough for Most Student Engineers

By Prof. Dugald C. Jackson
Massachusetts Institute of Technology, Cambridge

THE BEST INTEREST of the engineering profession and the engineering industries depends upon all of us who are related to engineering, whether in the active professional or industrial employment or in the educational field, giving balanced thought to the welfare of the methods of preparation of young men who go into the fields. Particular emphasis in this respect relates to engineering education of university order, since from this flows such a large proportion of the men who have taken, are taking and hereafter will take leading places for guiding the profession and the industries. The same tenet holds, however, with respect to the education of the less advanced level that is represented by the institutions that have come to be known as technical institutes, such as the Pratt Institute of Brooklyn and other similar institutions, and also to such work as is carried on by the committee of the American Society of Mechanical Engineers on engineering and training for the industries, which relates particularly to the equivalent of apprenticeship.

Though whatever Dean Kimball writes on the subject of engineering education is stimulating and informative, I am not ready to agree with him (if this is his view) that all students in engineering schools of university level should be expected to spend five years in their undergraduate course. It is my opinion that the best balance is now secured with the majority of the men following a four-year undergraduate course, but that a certain proportion of these may advantageously go farther with intensive study as graduate students. It is also a fact that some men, who can afford the time and the money, profit greatly by spending from two to four years in a college of arts before entering upon their engineering course and that in the latter they may pursue the work for a period from two to three years.

Lengthening the course for all carries the disadvantage of plunging all into their business with one year greater age, and this disadvantage, as well as that of expense, must be balanced off against the advantages to be derived in a man's future life. If all engineering schools could bring to bear more effective effort toward definite establishment of resourcefulness, originality, mental courage and initiative in their students, I imagine that there would be less argument favoring the lengthening of the engineering school course for all. Stirring these particular qualities is a difficult problem. Pressure for specialization of the type referred to by Dean Kimball seems to me, fortunately, to be on the wane, although it still exists to an unhappy degree.

Longest Bridge in the Balkans Is Completed

The bridge across the Danube joining Belgrade directly with the Banat, at Panchevo, has recently been completed. This bridge, 1,379 yd. long and 36 ft. wide, is the longest in the Balkan Peninsula and one of the longest in Europe. About 20,000 tons of steel and 100,000 cu.m. of concrete were required in the structure. The bridge serves for both railway and road transport and has been constructed so that if need arises it can be widened to 66 ft.

One-Way Streets and Grade Separations to Speed Traffic

By Robert Schlemm
Civil Engineer, Burnham Building, Chicago

CONGESTION of traffic in Chicago has reached the stage where there is less average intensity of use of the street facilities (cars per hour per mile of street) than of the roads in the surrounding county. The streets are inefficient. Clearly this is from lack of availability. To meet the needs of free-flowing traffic from any part of the city to any other part would require that a fourth of the existing street mileage be made into unimpeded through-routes unless more streets were built at enormous expense.

Continuous elevated or depressed structures have been proposed, but they are so costly and would require such a long time to build that any other plan to utilize what is now available is worth looking into. The author proposes the following scheme, called for identification the "four-square" separation. It consists of a checkerboard utilizing streets having no electric-car lines, with raised grade separations at important crossings. The details would be as follows:

1. Designate closely adjacent streets, without street cars, as one-way streets in opposite directions, preferably one on each side of a major business street.
2. Build four-square grade separations, to permit rational left turns wherever two sets of one-way streets cross.
3. Build overpasses for passing through-traffic over major business streets.
4. Between sets of through-streets close off (by curbing) as many residential cross-streets as possible, either entirely or partly, to permit turns onto or off through streets, but prevent cross-traffic.
5. Confine all structures to existing rights-of-way, so that no property condemnation is necessary and so that total damages will amount to no more than small awards for partial reduction of light and air at the grade separations.

Fig. 1—Adaptation of four-square plan to a complicated West Side situation in the city of Chicago.

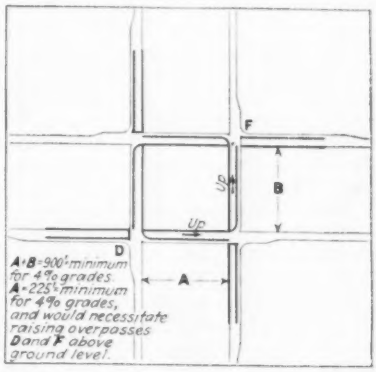
Fig. 2 shows the four-square arrangement in simplest form. Many modifications of the basic design are possible and necessary. Fig. 1 shows an adaptation to the Oakley-Campbell Ave. and Warren Ave.-Washington St. crossings in Chicago. Oakley Ave. and Campbell Ave. are ordinary 66-ft. streets paralleling the highly congested Western Ave., which is 100 ft. wide but has street-car tracks in the center and is lined with business houses. They are shown continuously elevated between the Metropolitan elevated railway and the Lake St. elevated railway, passing over four important adjacent east-west routes—namely, Washington, Warren, Jackson and Madison Sts., the last being a congested business street with electric surface lines. Each of these merits a grade separation for its own needs. Since they have been operated as one-way thoroughfares, Warren Ave. and Washington St. have shown the greatest improvement in traffic-carrying ability per dollar spent of any street change yet made by the city, a significant fact favoring the above proposal.

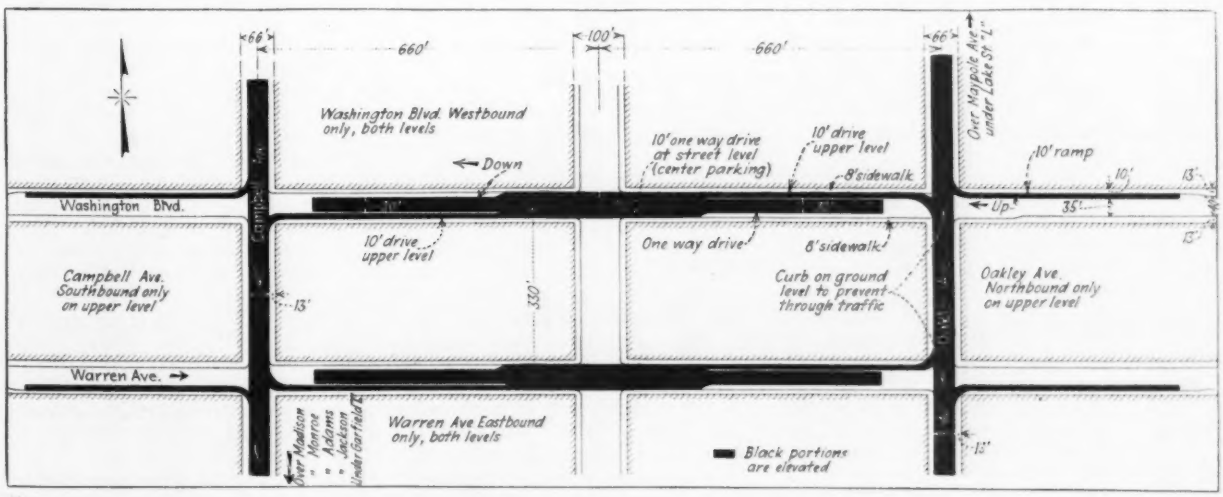
The arrangement in Fig. 1, a wide departure from the basic scheme, illustrates its adaptability to special conditions. When applied to this location, as shown, it would relieve the entire near west side of Chicago and would take a large traffic load off the three west-side parks, which now serve more as thoroughfares than as recreational facilities.

Grade separation at important points, perhaps a mile apart, is the only costly item in the proposed arrangement. This would be only a fraction of the total cost of a system of continuous superhighways, such as have been proposed for bond-issue construction by the city.

A checkerboard scheme of one-way through-streets with four-square separations would obviate completely the necessity for east-west and north-south or circumferential superhighways in Chicago, but there may still be a need for two diagonal radials to the northwest and southwest. These would necessarily have to fall into existing radial rights-of-way as two-way units because there are no parallel pairs of residential streets in these directions; they would almost certainly be continuous elevated structures abutting railroad rights-of-way. This possibility is mentioned only to point out that the recommended plan of through-streets, being mostly at ground level, would not interfere with these diagonals nor with existing elevated lines as seriously as would a system of north-south and east-west superhighways.

Fig. 2—Four-square grade separation with depressed underpasses in simplest form.





Professional Unemployment

—Its Effect on Civil Engineers

By H. M. Friend
Bronxville, N. Y.

UNEMPLOYMENT today is a major world problem. Never before during the lifetime of most of us has there been such a high percentage of the population unemployed, and never before has there been so much interest aroused in planning for their relief. Not only are emergency relief programs engaging the best efforts of the leaders of industry, but also the deepest thought is being given the study of plans for preventing the recurrence of such serious situations in the future.

Engineers are more concerned over these problems that the members of any other profession because the fluctuating volume of their work makes them more subject to unemployment during a business depression. Also, the entire problem of stabilization of business is largely one for engineering analysis and attack.

While the entire engineering profession has suffered from unemployment, the amount has varied in the different branches. Popular opinion assumes that civil engineers are the most seriously affected, since they are considered mainly as builders and constructors, a branch of industry badly affected in this depression. How large a part of the civil group actually is affected cannot be definitely determined, but an analysis of the available data makes it possible to arrive at deductions of interest.

The following estimate of unemployment among civil engineers in this country is made from a survey of conditions among members of the American Society of Civil Engineers, which on Jan. 1, 1931, had a total membership of 14,659. Unemployment among the members of this society is probably less than among non-members, for obvious reasons, but for the purposes of this discussion it is assumed that the employment conditions in the several occupational groups of its members will given a fair cross-section of the whole civil-engineering profession. For such an analysis the membership list has been broken down into the following groups.

Consulting engineers and staffs.

Government officials and engineering employees.

Executives and engineering employees of industrial and manufacturing companies.

Executives and engineering employees of engineering and construction companies.

Executives and engineering employees of public utilities.

Executives and engineering employees of commercial companies.

Educators.

Miscellaneous.

In order to make comparisons with the other groups of engineers the same classifications were made for members of the mechanical and the electrical societies. Fig. 1 shows this occupational analysis in graphical form based on the percentage of total membership in each of these eight subdivisions. By examining the employment status of each of the eight groups a clear picture of the unemployment situation in each of the societies can be obtained.

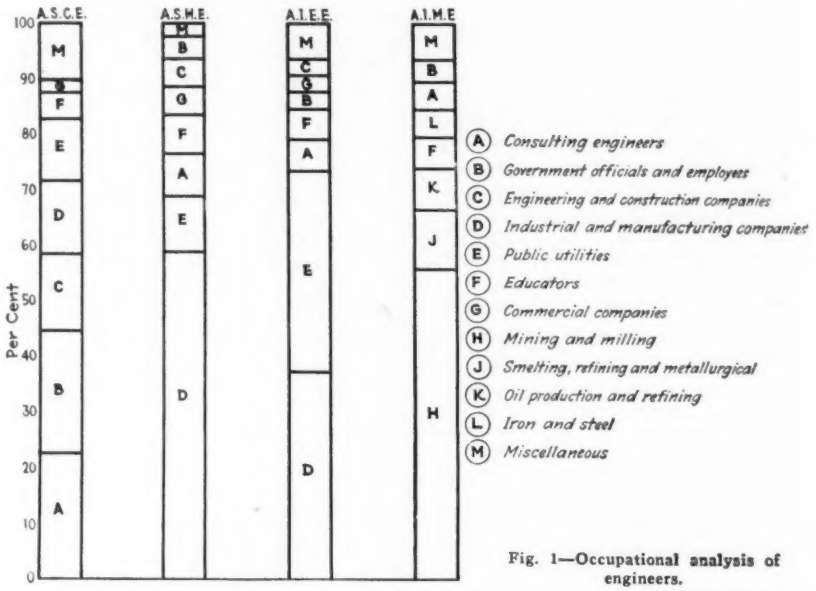


Fig. 1—Occupational analysis of engineers.

Unemployment among civil engineers

The two largest of the civil engineering groups are consulting (22.5 per cent) and government (22.2 per cent); they comprise about 45 per cent of the total membership of the society.

Consulting engineers have been seriously affected by the depression due to the almost complete cessation of large construction projects. In many consulting engineers' offices only a skeleton force remains. Many civil engineers are unemployed as a result of this reduction. There are indications that the total is nearly 20 per cent.

In the federal, state, county and municipal service, where the work is more stable than in industry, less unemployment should be expected. There are very definite figures covering employment in the federal government. In an article in the Nov. 12 issue of *Engineering News-Record* the writer showed that, based on figures collected by the American Engineering Council, the total number of engineers in the federal government had increased during each of the last five years. Other groups of engineers besides civils were included in that survey, but civil engineers predominate in the government service. Since that article was written the American Engineering Council has obtained additional data on the subject. The total number of engineers employed in the 34 bureaus and divisions that are the principal employers of engineers has increased 30 per cent since June, 1929, while for the same bureaus and divisions the total number of all employees increased only 11 per cent. There are no such definite figures available covering the employment of engineers in the state, county and municipal services. In some places there has no doubt been a reduction in employment, but in most the total numbers probably have not been reduced. At most, the unemployment in this group is not more than 2 per cent.

Most industrial and manufacturing companies have experienced a great falling off in their business during the past year and have reduced their forces considerably. This is especially true of those companies manufacturing heavy construction materials and equipment. From Fig. 1 it is seen that the number of civils in this branch is very much less than the mechanicals and the electricals. Except for engineers in executive and key positions there is considerable unemployment in this group, probably about 10 per cent.

In the engineering and construction companies employment conditions are

very similar to those with the consulting engineers. Building statistics show clearly the extent of the depression in this branch of industry. Unemployment among members of labor unions in the building trades was announced by the American Federation of Labor on Nov. 27, 1931, as approximately 52 per cent, while the total for all groups of labor in all unions was 20 per cent. Unemployment among the civil engineers composing this group is very heavy. A figure of 30 per cent was taken.

Public utilities have suffered less decrease in business than almost any branch of industry. Statistics show that their total load is running only about 5 per cent less than 1930, which in turn ran several per cent below the previous year. However, the net earnings of most of these companies are nearly equal to those of 1930. Normally there should be an increase from year to year of nearly 8 per cent in total load. Consequently, the falling off in business is considered by the utilities as being greater than that actually shown. Except for their construction departments, there has been no necessity to reduce forces. However, there is no construction work needed to increase generating capacity, as the utilities in 1930, at the request of the government, continued their normal construction programs. From Fig. 1 it is seen that civils are much less numerous in public utilities than electricals. However, they are more concentrated in the construction departments. A correct figure for unemployment in this group should be around 5 per cent.

Educators compose about 5 per cent of the members of the Am.Soc.C.E. Under this classification are included university executives, professors, instructors, teachers, librarians and editors. As the number of engineering students has not fallen off heavily in this depression and as actually there has been an increase of graduate students, the employment in this branch should be quite stable. Answers to inquiries sent to several of the leading colleges of civil engineering confirm this view. None show a decrease, and Rensselaer Polytechnic Institute reports an increase in instructors. For this study the unemployment among this group has been taken as 2 per cent.

Under commercial companies, the smallest of the groups for the civils, are included banking, insurance, law and sales agencies. There doubtless is considerable unemployment in this group, probably 10 per cent.

The miscellaneous group consists of those members that cannot be easily classified in the other groups. There is of course no information regarding unemployment among them. A percentage of unemployment of 10 has been assumed for them.

The following table shows the estimated amount of unemployment in these eight classifications for the members of the Am.Soc.C.E., based on the percentages unemployed assumed in the discussion of each of these eight groups.

	Per Cent	Number	Unemployed Per Cent	Unemployed Number
1. Consulting	23	3,372	20	674
2. Government	22	3,225	2	65
3. Industrial and manufacturing	14	2,052	10	205
4. Engineering and construction	13	1,906	20	380
5. Public utilities	11	1,613	5	81
6. Commercial	3	440	10	44
7. Educators	5	733	2	15
8. Miscellaneous	9	1,319	10	132
	100	14,660	11	1,596

This estimate gives a total percentage of unemployment for the members of this society of 11. For non-members this percentage is probably higher, say 25 per cent. Unemployment is especially high among surveyors, draftsmen and designers.

It is very difficult to obtain any actual data on unemployment with which to check these estimates. So far there have been no questionnaires sent the members of the engineering societies. At the present time, however, the Am.Soc.C.E. is obtaining definite information regarding unemployment among its members and also non-members throughout the country, and these data will soon be available. However, such a check-up will err on the low side of unemployment, since of the many who fail to answer the larger part would be among the unemployed.

The few registration places that have been established have shown a smaller percentage of unemployed engineers than had been estimated. For example, in New York City the estimates of unemployment run as high as 800,000, while the registrations at the emergency work bureau, when registrations were stopped on Dec. 5, 1931, totaled 117,000. The low registration of engineers is due not so much to an error in the estimates as to the fact that many do not register at emergency employment bureaus because they feel that registration will be of no assistance to them in getting a job in the present state of business. Another reason is the eligibility requirements of some of these employment offices. For example, most of these emergency bureaus will not give work to single men without dependents even though these men are destitute. Pride keeps some men from registering, and some are frankly waiting for the situation to turn before making an active search for a place. Then some unemployed engineers have found temporary work in other lines.

Registrations with unemployment relief bureaus do, however, throw some light on some phases of the question. As for example, among which group of engineers is there the most unemployment? From a study made by the writer of the Engineering Societies' employment service, published in the Oct. 27, 1931, issue of *Power*, Fig. 2 was taken. The figures for registrations and placements are the totals for the Chicago, San Francisco and New York offices of the employ-

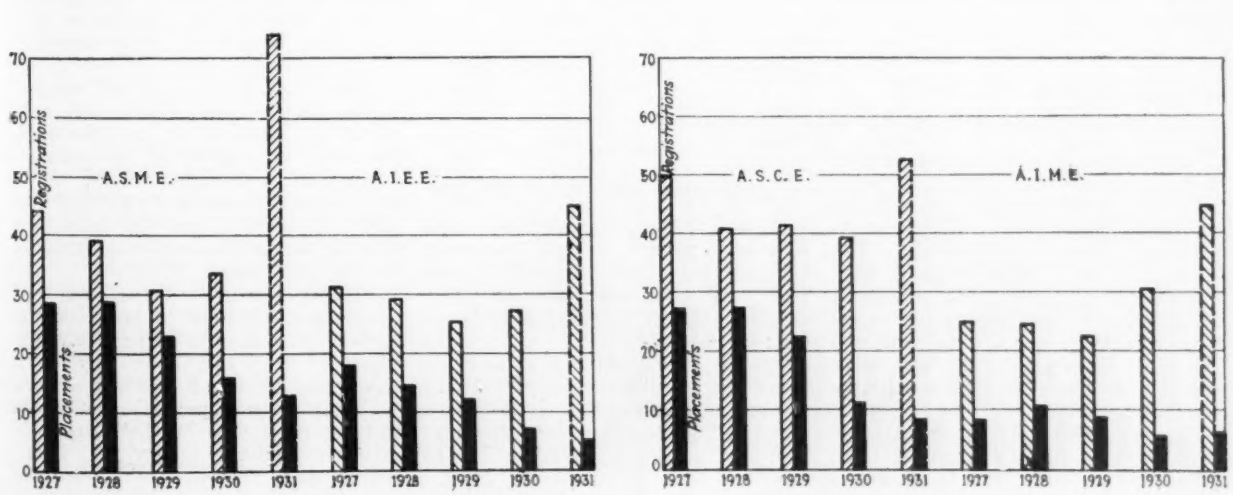


Fig. 2—Registrations and placement record of the Engineering Societies' employment service.

ment service. As the year 1931 had not ended when the study was made, the figures shown for 1931 are those for the first six months doubled. All computations were made on the basis of 1,000 members, so that the height of each of the graphs is an actual comparison. Before the spring of 1931 these figures also included non-member engineers. This chart shows that before this year there were more registrations and, therefore, more unemployment among the civil engineers but that during the current year the mechanicals moved to the top of the list.

Other registration offices such as that of the Professional Engineers committee on unemployment, which covers only the New York metropolitan district, also show for the four founder engineering societies a greater total number of mechanicals unemployed, with civils second and electricals a close third. If these figures are reduced to a basis per thousand members living in that district, civils head the list, with the mechanicals second and the electricals third. For non-members the civils are the most numerous, with the mechanicals second.

While the estimates in this article of 11 per cent (1,596 men) for the members of the Am.Soc.C.E. and 25 per cent (11,250 men) for non-member civil engineers show that there is now considerable unemployment among the profession, these numbers are not so great but that a moderate upturn in business and a revival in construction would rapidly absorb them.

Letters to the Editor

Specializing in Engineering

Sir—We are told that surveying is a branch of the engineering art—in fact, the oldest branch. A fair proficiency in surveying is necessary in other branches of engineering, such as highway, railway and drainage engineering; practically all engineering students are taught the fundamentals. Yet in many States, such as New York and New Jersey, land surveying is licensed as a distinct profession. The engineer may not practice it without special license, although according to D. B. Steinman, his fundamental training is sufficient therefor, if he so chooses to specialize. In certain other states, as Michigan, the engineer is permitted to practice surveying, although a special license may be issued for it as well. Here we have recognition both of professional solidarity and of the need of special licenses in certain instances.

ARNOLD B. STAUBACH,

New York, N. Y.
Nov. 23, 1931.

Conflicting Results in Water Measurement

Sir—Some time ago I had the opportunity of checking the flow of water, measured by means of a weir, with the California pipe method of water measurement described by Blake R. Van Leer in your issue of Aug. 3, 1922, p. 190. The agreement was very close. However, the thought occurred to me that, in view of the fact that the discharge nipple must be level and never run full, flow at the exit end must be at critical depth.

On trying to check the flow by this assumption, using the excellent table published by Julian Hinds in *Engineering News-Record* of Oct. 27, 1921, p. 693, totally different results were obtained.

This seems strange to me, as, to my mind, it appears to be a clear case where the application of the principles of flow at critical depth and velocity should govern.

In order to make the case clear, assume the diameter of pipe to be 6 in. and the depth of flow to be 2 in. Then (*ENR*, Aug. 3, 1922, p. 190),

$$K = (0.0116 + 0.00787 \times 6) = 0.05882$$

$$Q = 0.0588 \times 2^{1.88} = 0.217 \text{ sec.-ft.}$$

Turning now to the tables by Mr. Hinds, we find

$$\frac{d}{D} = \frac{1}{3}; \quad \frac{Q}{D^{5/2}} = 0.64.$$

As D in this case is in feet, we get

$$Q = 0.5^{5/2} \times 0.64 = 0.113 \text{ sec.-ft.}$$

This is about 50 per cent of the result by the first method.

Can some reader explain the difference and why the critical depth method does not check? GEORGE RIBEIRO,

Chief Construction Engineer,
The Great Western of Brazil Railway Co.
Pernambuco, Brazil,
Nov. 16, 1931.

Strand-Cable Suspension Bridges

Sir — The suspension-bridge cable made up of parallel, multiple, prestressed bridge strands is widely accepted as the most economical and satisfactory type developed to date for intermediate span bridges. In spite of the fact that such cables are rapidly gaining in favor, it seems that they are referred to by a number of different terms. To many they are "rope-strand cables;" to others they are "twisted-strand cables;" to us they have been "prestressed bridge-strand cables," and so on. Some proper designation obviously should be accepted and adopted.

The term "parallel-wire cable" is most descriptive of a cable type and is recognized by the engineering profession at large. It describes the cable exactly: "A cable made up of a number of wires, each of which is parallel to the other." But what does "rope-strand cable" bring to mind? What does the word "rope" signify? Is the strand twisted into a rope, or was it made as a rope strand? How are the strands laid into the cable? The term leaves us completely up in the air and is therefore far from descriptive.

The name "twisted-strand cable" is no more satisfactory. Are the strands twisted? No. they are laid parallel. Then why "twisted strand"? "Prestressed bridge-strand cable, is more to the point, but it is still far from satisfactory.

There are, in reality, only three types of wire suspension-bridge cables (we do not include cables of one strand or one rope); these are (1) those made up of a number of individual *wires* all lying *parallel* in the finished cable; (2) those made up of a number of twisted wire *strands*, the strands all lying *parallel* in the finished cable; (3) those made up of a number of wire *ropes*, the ropes all lying *parallel* in the finished cable.

The one thing that all three types have in common is that the unit members as delivered to the field are finally laid parallel in the cables. Wherein they differ is in these units: (1) wires, (2) strands, and (3) ropes. Then why not adopt as standard terms: (1)parallel-wire cables (universally recognized); (2) parallel-strand cables; and (3) parallel-rope cables?

To those in the wire world and to engineers generally the name "strand" implies a number of wires twisted together about a common center—the center wire. Any departure from this recognized meaning calls for a descriptive adjective; hence, "parallel-wire strands." Now, a "rope" is also a number of strands twisted or closed about a common center. But this center may be: (1) a hemp rope ("hemp center"); (2) a strand ("strand center" or "seven-strand rope"); or (3) a wire-rope center ("independent wire-rope center"). Thus if we use the term "twisted," in speaking of the parallel-strand cable, we rightly should use it twice when designating the parallel-rope cable, as in this type the wires are twisted into strands and the strands are twisted into ropes.

Parallel-rope cables have been used on numerous smaller bridges, but the modulus of a rope is so relatively low compared with that of a wire or a strand that their use is distinctly limited.

The strands of a parallel-strand cable and the ropes of a parallel-rope cable may or may not be prestressed. However, without prestressing, the modulus

values are low and the elastic behavior erratic for both. We believe the three classifications of suspension-bridge cables given above are sound.

CHARLES M. JONES,
Assistant Chief Engineer, Bridge Department, John A. Roebling's Sons Co.
Trenton, N. J.,
Dec. 21, 1931.

* * *

Sir—The following is our recommended nomenclature for cables: (1) parallel-wire cables; (2) twisted-wire strand cables; (3) twisted-wire rope cables; (4) eyebar cables.

Alternative designations for No. 2 are "strand cables," "wire-strand cables," or "parallel-strand cables," with corresponding designations for No. 3 substituting the word rope for strand.

We prefer the designations we have tabulated above for the following reasons:

1. The word "twisted" gives a clearer picture of the construction, in contradistinction to the word "parallel" in the designation of No. 1.

2. The word "wire" prefixed to "strand" or "rope" is desirable to fix the impression of steel wire being used, and corresponds to the establish use of the term "wire ropes" by the manufacturers.

3. The designation "parallel-strand cables" seems not to be sufficiently distinctive from the usual construction in which the parallel wires are also assembled in parallel strands.

4. The word "strand," to most laymen, means an individual wire or filament, so that such designations as "parallel-strand cables" or simply "strand cables" would not be sufficiently distinctive in the picture they would convey.

After several conferences among the members of our organization, we have reached the conclusion that the above tabulated designations should be followered for maximum clarity at the present time.

D. B. STEINMAN,
Consulting Engineer.
New York, N. Y.,
Dec. 31, 1931.

Bid Shopping

Sir—In connection with your editorial on bid shopping in the Nov. 12 issue, we would like to offer the following suggestion as a remedy for eliminating this practice by general contractors.

We believe that in the letting of public works, in particular, it should be required that general contractors submit, in addition to their lump-sum bid, a list of names with the bid prices of subcontractors that they used in compiling the bid. It should then be required that the general contractor let subcontracts as per this list. In other words, we feel that under present conditions the municipality, state or federal government should be as responsible in seeing that the subcontractor who is low with the general contractor be awarded his work at his bid price as in seeing that the low responsible general contractor be awarded his work.

It should also be compulsory, to make this list complete, that general contractors take sub-bids on all items that they do not intend to and cannot actually handle themselves. This would afford the subcontractor an opportunity of determining his position in the bidding at once, making it impossible for the general contractor to do any shopping on this item. It would, in addition, tend to make both the general and subcontractor turn in a legitimate bid on which a reasonable profit is included.

We are offering this merely as a nucleus of a plan which we hope will clear up a distressing situation. We realize that such a plan for bidding will require considerable study to make it fool-proof and practical.

MARTIN F. BLUFSTON,
President, Atlas Construction Co.
St. Louis, Mo.,
Dec. 23, 1931.

The above plan follows closely the one that Representative Goss included in a bill presented to Congress, as reported in Washington Notes, Dec. 24, 1931, p. 1,017.
—EDITOR.

A New Type of Dam

Sir—Modern engineering has realized the perplexing uncertainties existing in the design of a gravity dam, and recent tests have shown that some of these uncertainties are well founded and of difficult practical solution. That sometimes this antiquated and illogical type of structure imposes itself by the physical conditions of the site is unfortunate enough; but why it should be adopted in places where an arch dam would be the logical solution is not quite clear. To be sure, the solid arch dam, while avoiding some erroneous assumptions—as, for instance, that concerning the upward hydrostatic pressure—and using the material in the most logical and economical way, has some uncertainties in common with the gravity dam—as, for instance, the law of distribution of the hydrostatic pressure at a given level of the water back of the dam.

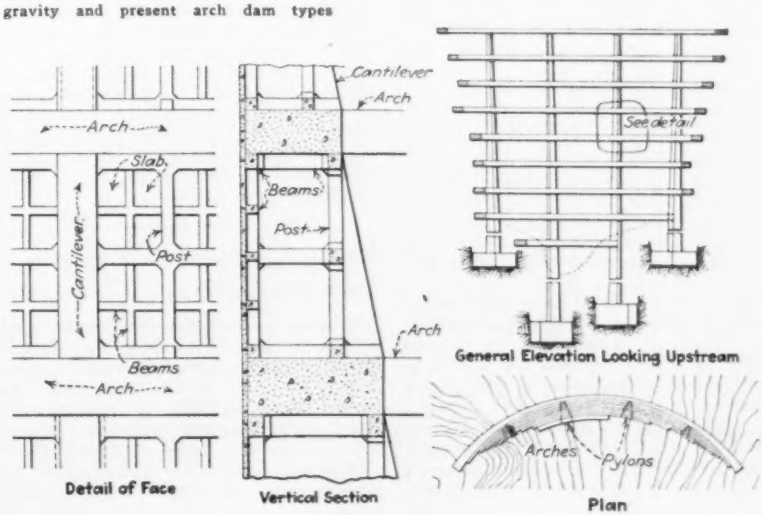
With these facts in mind, a new type of arch dam has been evolved, which does away with practically all doubts and brings this important structure into a field well known to engineers. The frame of this structure consists of pylons and arches; the water face is formed by slabs. The pylons, or cantilevers, extend down to solid rock. The arches are supported by the pylons and by intermediate posts. The arches abut against solid rock properly prepared to receive them, just as is done in a case of a bridge arch. Two systems of beams, one horizontal and the other vertical, run in each panel formed by two consecutive rings and two consecutive pylons. Against these beams, slabs are set with calked joints, so that these slabs are independent of each other; they are held in place by stirrups projecting from the beams.

In order to give somewhat more freedom to this structure it is advisable to leave the central section of it free from pylons, as shown.

This is a general outline of the new type of dam, the details of which are subject to variations suggested by the physical conditions of the site in any particular case. In my opinion the type is capable of more definite precalculation of performance than existing types and at the same time is more economical. In certain specific cases for which I have carried out complete designs the economy reached two-thirds as compared with a solid arch dam.

A. C. JANNI.
New York City,
Dec. 10, 1931.

An articulated arch dam proposed as solution of the difficulties inherent in gravity and present arch dam types



NEWS OF THE WEEK

Mead Plan for Irrigation District Relief Is Opposed

A TWO-DAY SESSION of the federal irrigation congress was held in Salt Lake City Dec. 29 and 30, attended by delegates representing 23 reclamation projects in fifteen Western states.

The Mead plan for relief, which provides for a loan to the irrigation districts amounting to one year's fees at 6 per cent interest, was the principal subject for discussion, and was vigorously opposed by most of the delegates present. As a compromise it was decided to present to Congress a bill providing for payment of 5 per cent gross crop returns to the government for 1931, 1932 and 1933, instead of the regular government charges, which most irrigation farmers reported they cannot meet. The organization also went on record as opposing the Thomas plan for a three-year moratorium.

Bill to be drafted

A committee was appointed by G. W. Grebe, of Kuna, Idaho, president of the congress, to consider the compromise suggestions and draft a bill for the congress to support. It is composed of W. C. Paul, representing the Minidoka project at Rupert, Idaho; B. P. Flemming, representing the Truckee-Carson project at Fallon, Nevada; N. B. Coffman, representing the Uncompahgre project at Olathe, Colorado; T. A. Walters, representing the Wilder and Black Canyon projects at Caldwell, Idaho; Henry Erlandson, representing the Strawberry project at Payson, Utah, and President Grebe.

J. T. Whitehead, Washington representative of the federal irrigation congress, told the delegates that his contact with congressional representatives in Washington had convinced him that it would be futile to ask for an outright moratorium, either for one year or for three years. He further said that there is no certainty that the 5 per cent plan can be passed.

Pittsburgh Creates Department of Highways

The new board of commissioners of Allegheny County (Pittsburgh), Pa., has unanimously voted to reorganize the entire structure of county government by creating six departments. The heads of these departments will begin their terms of office Jan. 16.

Among the new departments created is the department of highways, to succeed the old department of public works. Its function will be to direct building and maintaining of all county highways, bridges and tunnels.

Because of the condition of the county finances, it is announced that many positions will be made non-existent through the abolition of the department of public works.

Additions Made to President's Fund for Engineer Relief

Two contributions recently sent to the Professional Engineers' Committee on Unemployment, New York, have been added to the special fund set up by the committee for national relief work, a fund known as the President's fund because it was established following the receipt of a contribution of $5,000 from President Hoover. The contributions added to the fund are $2,500 from the Engineers Club, New York, and $1,000 from the McGraw-Hill Publishing Co.

Administration of the fund has been placed in the hands of a committee representing the national engineering societies. It is made up of William G. Atwood, Ely C. Hutchinson, L. E. Strobel and E. B. Meyer. Distribution of the fund to local relief organizations will, in so far as possible, be based upon the per cent of the total membership of the national societies resident in the district under consideration.

Work Planned in Montreal to Relieve Unemployment

The city of Montreal has planned work for the relief of unemployment, with the aid of the dominion and provincial governments, involving an expenditure of $4,800,000. The program embraces 40 works. The more important of the undertakings and the estimated cost are as follows: St. Joseph's Boulevard tunnel, $550,000; Papineau St. tunnel, $540,000; repairs to St. Denis St. tunnel, $240,000; repairs to St. Jean Baptiste market, $225,000; Cote des Neiges tunnel, $275,000; gymnasium, $200,000; Gosford St. tunnel, $275,000; Salaberry St. tunnel, $150,000.

Ohio Building Bridges for Unemployment Relief

Ohio's bridge-building program calling for the erection of more than 380 structures during the winter as part of Gov. White's plans for unemployment relief was completely under way on Jan. 8, when O. W. Merrell, state highway director, opened bids for the construction of more than 54 bridges in 33 counties, at an estimated cost of $515,161. The completed program will provide about $3,500,000 for work.

Heavy Rainfall in Arkansas Damages Highways

A heavy rainfall the first of last week, averaging from 1½ to more than 4 in. in almost every section of Arkansas, caused sudden rises of creeks and rivers and caused much damage to bridges, road shoulders and gravel roadways. Several miles of highways in the south central and southwestern sections were inundated. No estimate of the amount of damage has been made.

Waterworks Men Plan Emergency Betterment Work

REALIZING that some work relief plan by the federal government may be necessary and that any money so appropriated should be used where it will bring in a commensurate return in value of the work done, the American Water Works Association has outlined the approximate amount of work that can be undertaken at once by cities for the betterment of their water supply and distribution systems and has laid down a program for getting such work under way at the earliest possible date. The association's committee on waterworks practice, headed by Malcolm Pirnie, has organized a subcommittee on waterworks betterment to plan for the most effective use of federal funds if, as now seems possible, the federal government undertakes to lend the money to states and municipalities for various kinds of emergency work. Bills now before Congress provide for large federal bond issues for such purposes.

Amount of work needed

The committee estimates that the following amounts of money could be expended in the immediate future on waterworks betterment:

For reinforcement of distribution systems	$200,000,000
For replacement of undersized pipes in distribution systems	100,000,000
For distribution system extensions	50,000,000
For new or additional supplies or purification works, represented in part by deficiencies in 1931 and 1932 waterworks improvement budgets.	200,000,000
	$550,000,000

This estimate does not include large water-supply projects such as those of New York, Los Angeles and Philadelphia.

The committee points out that many water systems are sadly deficient in supply, as demonstrated by the 1930-1931 drought, and in distribution pipes, particularly in street mains of sufficient size and suitably interconnected to provide adequate fire protection; also that much of the work of making up this deficiency is of a character which can be undertaken within a short time and which will provide a considerable amount of hand labor without sacrifice of efficiency. Existing local water departments can take charge of the work.

The committee states that although plans are already in existence for a large proportion of this work they will not be carried out at present unless financing is made attractive and the work receives general approval as a relief measure. Little if any land would have to be acquired, as the work is largely in public streets and on lands already owned.

To the extent that federal aid may be advanced for waterworks betterments present municipal credit will be made available for other badly needed work. All the work

contemplated will produce real values which will pay their way and be paid for by the people benefited.

The committee on betterment planning consists of Harrison P. Eddy, consulting engineer, Boston, chairman; M. R. Maltbie, chairman of the New York State Public Service Commission; George W. Booth, chief engineer, National Board of Fire Underwriters; C. W. Mowry, Factory Mutual Fire Insurance Companies; W. W. Brush, department of water supply, New York City; Capt. Hugh P. Oram, engineer commissioner, Washington, D. C.; Reeves J. Newsom, vice-president, Community Water Service Co.; Donald H. Sawyer, Federal Employment Stabilization Board; and Morris R. Sherrerd, George W. Fuller and R. C. Marshall, consulting engineers.

New Charter Becomes Effective in San Francisco

A NEW FORM of government went into effect in the city and county of San Francisco Jan. 8, when the new charter, approved by the people March 26, 1931, replaced a charter in force for 31 years. Under the new charter there is a clear-cut separation between legislative and administrative powers. (*ENR*, April 9, 1931, p. 623.)

In the mayor, Angelo Rossi, who succeeds himself, is vested a centralized executive responsibility through his appointive and executive budget powers. The major appointments of engineering interest made by the mayor are the chief administrative officer and the public utilities committee, both created by the new charter. The annual budget in the future will be made out by the mayor instead of by the board of supervisors, as formerly, with final approval vested in the supervisors.

Alfred J. Cleary, chief administrative officer (*ENR*, Dec. 31, 1931, p. 1052), will be in charge of eleven municipal departments, including electricity, public works, health, purchasing, finance and records. He may be removed by the mayor, by two-thirds vote of the supervisors, or by popular recall.

New department heads

Mr. Cleary has appointed William H. Worden, member of the former board of public works, director of public works, in charge principally of street work, sewers and buildings.

Lewis F. Byington, San Francisco attorney and former member of the board of supervisors, has been appointed by Mayor Rossi chairman of the new public utilities commission. Mr. Byington was president of the board of freeholders which wrote the new charter. The four other members of the commission are representative business men of the city. This commission of five is responsible for the management, control and operation of the municipal railway system, San Francisco water department, Hetch Hetchy aqueduct construction, airport and any other utilities that may be acquired and operated by the city and county. The commission is required to appoint a manager of utilities as the chief executive of the commission, who in turn is authorized to appoint and remove, subject to the approval of the commission, the head of each utility under the commission's jurisdiction. Under the old charter the management and operation of the city-owned utilities was divided between the board of public works and the supervisors. The utilities commissioners are appointed for a four-year term and are subject to recall and to removal on charges the same as elective officials.

The creation of the utilities commission and the reorganization of the department of public works has automatically done away with the major responsibilities the position of city engineer has previously carried.

New Jersey Highway Commission to Classify Bidders

All bidders on state highway work in New Jersey are to be classified according to regulations adopted by the state highway commission on Jan. 5. Prospective bidders will be classified under the following headings: general construction work, grading work, paving work, and bridge construction.

Each bidder who qualifies for any one of the four classes will be graded according to financial ability, adequacy of plant and equipment, organization, and prior experience, also such other pertinent and material facts as may seem desirable. Details of the requirements are set out in the commission's resolution.

Bids will be accepted only from persons qualified in accordance with this classification. Bidders dissatisfied with their classification will be granted a hearing by the commission.

Ohio Contractors Organize Concrete Pavement Association

The Ohio Concrete Pavement Association was organized recently at a meeting held in Columbus composed of concrete road contractors. Allied interests are admitted to associate membership. Fred I. Rowe, Johnson Construction Co., Hicksville, was named president; John F. Stambaugh, Ada, first vice-president; B. C. Biody, Truscon Steel Co., Youngstown, second vice-president; and R. S. Frame, Jr., American Aggregate Corp., secretary-treasurer. Permanent headquarters will be established in Columbus.

Lecture on Construction Industry

A lecture on the construction industry is to be held at the New School for Social Research, New York, on Jan. 20 at 5:20 p.m. The subjects are to be the economic position of the industry, by L. Seth Schnitman, chief statistician, F. W. Dodge Corp., and social planning and the construction industry, by Robert D. Kohn, president, American Institute of Architects.

Plan to Remodel Ohio's Highway Administration

A bill providing for a highway commission of six relatively low-salaried members, which will have control of Ohio's roadbuilding reconstruction and repair program, will be introduced at the next regular session of the general assembly in accordance with a recommendation of a majority of the special Senate highway investigation committee, submitted to Gov. White.

The recommended plan calls for a commission of six members, holding office for six years, two to retire every two years. The commission would name the highway director and fix his salary.

The object of the plan is to remove political and commercial influence from the state highway department, stabilize state highway policies and insure proper expenditure of funds, attract outstanding men to the executive staff of the department, and assure these men of tenure of office free from political interference.

On Jan. 6 400 miles of county highways were taken over by the state, bringing the total mileage of roads under state maintenance to 11,743. The mileage added represents the maximum allowed by law and precludes the taking over of any other roads before 1933.

Rock-Lowering Contract Begun in San Francisco Bay

Rock-removal work has been started in San Francisco Bay to lower five of the most important rock clusters from about El. —35 to El. —40 ft. The contract is being carried out by Siems-Helmers, Inc., San Francisco, and involves drilling and removal of 40,000 cu.yd. of rock with an allowed overbreak of 2 ft. A special drill barge 110x35 ft. equipped with two drills has been built with spuds for raising the barge during drilling operations.

Tulsa Plans $1,500,000 Work for 1932

Grade-separation work at Tulsa, Okla., for the coming year is to include subways under the Missouri-Kansas-Texas R.R. at Boston Ave., $170,000, and Boulder Ave., $150,000; Quanah Ave. viaduct over the Belt Line, $125,000, and the widening of Arkansas River bridge and completion of 21st St. bridge, $725,000, a total of $1,170,000. In addition there will be the widening of four main streets at a cost of $402,000.

$5,000,000 Bridge Planned for Vancouver, B. C.

In the general plan of development at Vancouver, B. C., it is now proposed by the First Narrows Bridge Co. to construct a suspension bridge across the Lions' Gate to cost $5,000,000. Tentative plans, drawn by Monsarrat & Pratley, consulting engineers, Montreal, and W. G. Swan, consulting engineer, Vancouver, provide for a 1,400-ft. channel and a clearance of 200 ft. above high water.

Engineering Work in Detroit Curtailed to Maintain City Credit

BECAUSE of the conditions imposed by the bankers from whom the city is trying to borrow, Detroit is discharging half the engineering employees of the department of public works and making a universal 10 per cent reduction in the salaries of employees retained. All other city departments also have their operating budgets cut severely. No new construction can be undertaken for the next two to five years.

Unpaid taxes and carried-over deficits combine to reduce the sum available for municipal purposes for the year from the budgeted $76,000,000 to $57,000,000. Of this amount $30,000,000 is necessary for charges on the public debt, leaving only $27,000,000 for operating expenses. To get through the year the comptroller has endeavored to borrow $8,500,000. The banks laid down the condition that the city's expenses be kept within the amount available.

Salaries cut 10 per cent

The severe curtailing of expenses will be accomplished by cutting salaries, reducing forces and discontinuing some of the municipal services. All salaries will be cut 10 per cent. Salaries more than $4,000 per year will be reduced an additional 10 per cent of the excess.

All city departments will be skeletonized. Hardest hit is the department of public works, where a cut of $500,000 is to be effected. Two divisions of the department, the construction and asphalt divisions, will be closed entirely. In the city engineer's office alone a saving of $300,000 is to be made by laying off half the employees, mostly survey parties. According to Joseph E. Mills, commissioner of public works, the city's financial position is such that no construction work will be possible for the next two to five years, making construction and engineering staffs unnecessary.

Maintenance work curtailed

Maintenance work will be reduced to a minimum. The paving division will do only sidewalk and patching work. The motor-transport division will have its budget cut 30 per cent. Many city-owned cars will remain in the garage unused because of the reduced expenditures by other departments. Sewer maintenance will also be greatly reduced.

All municipal services will be curtailed severely. The health department is to discontinue its dental service and will materially reduce its school health service. Efforts are being made to raise private funds to keep the art museum and the rapid transit commission functioning. The school system will be required to make a big cut, but definite plans have not yet been formulated.

Other Cities Cut Pay or Reduce Engineering Personnel

In Chelsea, Mass., 115 employees of the city have been discharged in order to reduce the budget by $160,000. Employees discharged include 83 in the highway department, nine in the building department and five in the water department.

The Port of New York Authority has completed some of its work, which has resulted in reduction of personnel, particularly in the engineering department. In order that as many of the staff as possible may be retained, the employees have voluntarily agreed to a reduction of 5 per cent on salaries between $5,000 and $12,000 and 10 per cent on salaries more than $12,000.

In the city of New York the board of estimate and apportionment on Jan. 12 transferred to a so-called "suspense calendar" city projects totaling $110,000,000. These projects will be postponed until the city's finances are in better condition. They include additions to parks, new schools, playgrounds and acquisition of real estate in connection with the Delaware River water supply.

Ten per cent salary cuts for all city employees of Salt Lake City, Utah, were made at a meeting of the city commission on Dec. 30. The saving involved is reported to be about $140,000. It was necessary to make this cut in the budget before the banks would agree to make a loan of $750,000 to meet tax anticipation notes and interest falling due Jan. 2.

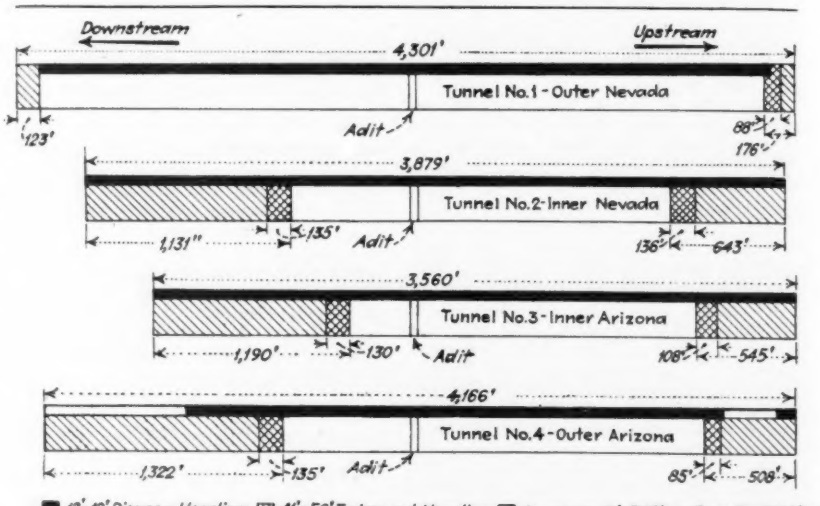
A decrease in pay affecting 125 men in the engineering division of the city of Syracuse, N. Y., has been ordered by Mayor Marvin. This is the only branch of the city government in which the salary cut of employees has been more than 10 per cent.

Federal Loans Proposed to Levee and Drainage Districts

LEGISLATION authorizing the use of long-term federal loans to aid in refinancing levee and drainage districts was reported to the House favorably on Jan. 11 by Representative Hall, of Mississippi, chairman of the committee on irrigation and reclamation. Under the terms of the bill, drainage or levee districts that are unable to meet either the interest or principal of their outstanding bonds may refinance their undertakings by applying to the Bureau of Reclamation for long-term loans, with non-interest-bearing bonds as security. A revolving fund of $100,000,000 is provided in the bill and it is stipulated that no loans shall be made for longer than 40 years.

Representative Whittington, of Mississippi, has expressed the opinion that there is as much reason for the federal government to aid in drainage work as to aid in the reclamation of arid lands. He believes there is ample constitutional authority for the extension of aid by the federal government to drainage districts.

According to information supplied the committee there is a total population of 5,000,000 living within drainage districts, mostly small farmers. The drainage bonds outstanding in 1930 totaled $79,671,426. It was brought out during the hearings that the drainage tax in many districts amounts to more than half of all the taxes the farmer has to pay. The secretary of the interior is directed, before approving a loan under the bill, to make an examination to determine that the drainage works are operating with reasonable success. He must also make an appraisal of the value of the taxable property of each district applying for a loan to satisfy himself that it can be repaid at maturity.



PROGRESS OF HOOVER DAM DIVERSION TUNNELS TO DEC. 26, 1931

The above chart shows the progress to Dec. 26 of the 41x56-ft. enlarged headings being driven in the four 56-ft. diversion tunnels at Hoover Dam. The five-day progress from Dec. 20 to Dec. 24, inclusive, is also shown. A total of 5,638 lin.ft. of the large headings had been driven to Dec. 26. This chart corrects a similar one published in our Dec. 31 issue, in which the totals of the enlarged headings were in error, the chart showing the progress of the week Dec. 5-12 instead of total to Dec. 12 as was represented. Likewise the total progress of enlarged headings given in Hoover Dam Notes published Jan. 7 is in error, 5,638 ft. to Dec. 26 being the correct figure.

Institute of Hydraulic Research at Iowa City

To afford an agency for the coordination of the talent, facilities and the resources that may be made available at the University of Iowa for undertaking projects of unusual magnitude, scope or complexity in the field of hydrology and hydraulic engineering the Iowa state board of education announces the organization of the Iowa Institute of Hydraulic Research at Iowa City. Consultants from the university staff and an advisory committee of practicing hydraulic engineers are available. Prof. C. C. Williams, dean of college of engineering, is chairman of this advisory body. Floyd A. Nagler is director of the laboratory, which is a four-story building with an elevated tank with facilities for model experimentation.

Concrete Pavement Yardage

Below is a tabulation of concrete pavement yardage awarded in the United States during the month of December, divided according to roads, streets and alleys, and the totals for the twelve months' period ended Dec. 31.

	During December	To Dec. 31
Roads	4,215,154	111,853,352
Streets	1,034,252	21,729,115
Alleys	114,735	906,356
Total	5,364,141	134,488,823

Capital and Contracts

New capital issues for 1932 up to and including Jan. 9 amounted to but $3,000,000, compared with the weekly average of $23,000,000 in September, 1931, and $81,000,000 for January, 1931.

The $3,000,000 consisted of four public issues—two county and two municipal. There was no private capital in the market for the week ended Jan. 9.

COSTS AND CONTRACTS

ENR Index Numbers

Cost			Volume		
Jan. 1,	1932	162.48	Dec.,	1931	133
Dec. 1,	1931	166.23	Nov.,	1931	180
Jan. 1,	1931	194.48	Dec.,	1930	192
Average,	1931	181.35	Average,	1931	220
Average,	1930	202.85	Average,	1930	260
1913	.....	100.00	1913	.....	100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of Jan. 14, with some comparisons, total as follows:

(In Thousands of Dollars)

	Jan. 14, 1932	Average of Last Four Weeks 1932-31	1931-30
Buildings:			
Industrial	$713	$1,730	$3,072
Other	18,964	9,229	16,357
Streets and roads.	806	2,945	4,731
Other construction.	6,509	9,882	24,078
Total	$27,992	$23,788	$48,239
Total, all classes, Jan. 1 to Jan. 14:			
1931			$51,181
1930			160,195

Why Contractors Grow Gray

COPY OF A LETTER recently received by a well-known veteran of the contracting business. Uncertainty as to the wisdom of taking up the interesting proposition threatens to age him prematurely. He admits that contracting is "a kind of a hard graft these times anyway," but he does not like the idea of a cooler. —EDITOR.

Dear Sir—After a good deal of inquiry and lots of time spent, I have just found out where you live and I will write this quick before it is too late in the season.

Our season is nearly over up here in Connecticut, but you are a lot farther South and so your Season will run for some time yet, or at least I hope so. You may not remember my name, but I am the cider merchant who had a talk with you a couple of years ago one Fall day when you stopped in here at my place of business. I remember very well that you said you owned a lot of apple trees and you were interested in the apple and cider pressing business, and so I was thinking that now with this years big apple crop and the terrible low price, that maybe we could do some business this year on the cider proposition unless you have already tied up with some other guy before this. You remember that you said at that time that you had plenty of money, and I said I knew the cider business from the bottom up, so I was wondering if we couldn't get together and me use some of that money and set us up a nice side line business down your way. My proposition would be for you to furnish the cash and me to chip in the "know how" and experience. Since you saw me here that time one of my neighbors double crossed me and I got picked up and had to spend a stretch of time in the cooler, for a little side line stuff that I was accommodating the boys with, but that sure taught me a lesson and I don't think I will get caught again, and anyway I'm almost sure that even though you are my pardner that you wouldn't have to do no time if we did happen to be unlucky with the side line stuff, which is where the real money game is. You are used to taking chances in that contracting business you are in, so why not take a chance with an old timer like me and we will pick us up some of this easy money these days, as long as you have got the trees and the cash. We can get a press in short order and get going quick.

You probably know lots of big shots down your way who would be glad to get some real stuff made by the boy who knows how to make it. And from what I hear lately this contracting game is a kind of a hard graft these times anyway, so you may not be so busy at that, even if we should get pinched, but I don't think that will happen this time as I will use my head and keep us clear.

Please let me know quick about this and I will be right down and we will get started. Yours truly,

Slick ———

P. S. My real name is Bill, but the boys always call me Slick as a kind of a nick name.

Washington Notes

By Paul Wooton

Washington Correspondent

HEARINGS on the bill authorizing appropriation of $125,000,000 annually for federal aid to the several states for highway construction for the fiscal years to end June 30, 1934, and June 30, 1935, will begin Jan. 18 before the roads committee of the House of Representatives. The measure also proposes authorization of $12,500,000 for forest roads and trails and $3,000,000 for roads on the public domain. Indications are that the committee will not propose an emergency appropriation for road work next spring and summer. The state highway commissions are not enthusiastic about payments in advance which will be deducted later. President Hoover is said to be much concerned over reports that the highway system already is in excess of needs in most localities.

Flood-Control Hearings Are Postponed

The flood-control committee of the House did not begin hearings this week as was planned. When the first volume of the report of the engineers on the restudy of the flood-control plan was delivered last Saturday to the members of the committee, they requested that Gen. Brown's appearance before the committee be delayed until they should familiarize themselves with the report. This is expected to mean that Gen. Brown will not be called until Jan. 21.

Hearings to consider arguments for and against compensation for damages occasioned by levee setbacks are expected to begin next week. These hearings will be continued until testimony has been taken covering all of the proposed amendments to the flood-control act.

Gen. Brown already has revealed that he will suggest to the committee that Congress authorize additional engineering studies to include a survey of the possibilities of increasing the discharge capacity of the Mississippi River between Arkansas City and Red River Landing and the discharge capacity of the Atchafalaya River. Experiments with a small-scale model of the Greenville bend indicate that the elimination of that single stopcock in the Mississippi would reduce flood heights by 10 ft. at the Cypress Creek fuseplug. No one of the proposed changes in the flood-control project can be made without adding to its total cost, Gen. Brown will tell the committee. This will mean that a careful estimate of cost will have to be made so Congress can authorize the necessary increase in the appropriation.

To Investigate Rumored Defects in the "Akron"

After the $700,000,000 naval construction bill has been disposed of, members of the House committee on naval affairs have agreed to take up an investigation of rumored defects in the naval dirigible "Akron" in response to a request by Representative McClintic, of Oklahoma. If there is any foundation to such reports, Mr. McClintic believes that the matter should be established as soon as possible in order to prevent the duplication of the same errors in the sister ship which is now under construction.

Brief News

WORK for 1,200 unemployed men will be provided immediately in Buffalo, N. Y., on a million dollar water main extension program. The state unemployment relief commission has allotted $300,000 toward the cost.

CONTRACTORS to whom is due a total of more than a million dollars for construction on the Arkansas state highway system must wait for their money until funds are received from some source, it is announced by Charles S. Christian, state highway engineer.

NOTICE OF APPEAL to the state supreme court has been made from the decision of the Los Angeles, Calif., county superior court validating the $220,000,000 Colorado River aqueduct bond issue voted by the Metropolitan Water District of Southern California. The appeal is filed by a Long Beach taxpayer.

VOTERS of Ventura, Calif., on Jan. 7 approved a freeholders' charter providing for a city manager form of government to supplant the mayor and council system. The charter must be sanctioned by the state legislature. A $100,000 street bond issue was carried by a substantial majority at the same election.

BIDS HAVE BEEN REJECTED by the Indiana highway commission on 2,000,000 bbl. of cement for the year's paving program because much lower prices have been made available in Illinois. The bids received averaged between 99c. and $1 per barrel, while the Illinois price is from 11c. to 30c. per barrel lower.

BETTERMENTS and additions to its system, estimated to cost nearly $4,000,000, will be made during 1932 by the Los Angeles Gas & Electric Corp. About half of this amount will be for this year's share of construction work on the addition to the Seal Beach electric generating station. This project will not be completed until 1933 and will cost about $3,500,000.

A ROAD SCHOOL (the 21st annual) will be conducted by the Wisconsin highway commission in Madison Jan. 25-28. The purpose of the school is to bring together state and county officials in order that they may cooperate better in providing highway facilities to serve the present heavy traffic.

Personal Notes

THOMAS E. COLLINS has been appointed chief engineer of the newly created municipal water department of Elizabeth, N. J. Mr. Collins has also been reappointed city engineer, a position he has held continuously for twenty years.

T. B. WARDEN, highway department manager of the Chamber of Commerce, Houston, Tex., has resigned to become district engineer for the Portland Cement Association, with headquarters in Dallas.

IVAN R. AULT, of Ashland, Ohio, has been appointed highway division engineer for state division No. 3, comprising Lorain, Erie, Huron, Crawford, Richland, Ashland, Wayne and Medina counties, succeeding T. S. BRINDLE, who has been made state director of public works.

RALPH E. GARVIN, of Cleveland Heights, Ohio, became city manager of Springfield, Ohio, on Jan. 4, succeeding Clyde E. Wallingford, who has gone to Newport, Ky., as city manager. WILLIAM E. LUCAS, city engineer for 12 years, is to be ousted, Mr. Garvin taking over the duties of that office.

WALTER E. CARROLL, of Antonito, Colo., has been appointed irrigation engineer for district No. 3 by Gov. Adams, to fill the vacancy caused by the death of E. G. Counselor.

GEORGE T. SANFORD, formerly assistant director of reclamation economics and previously superintendent of the Sun River project in Montana, has been appointed chief of the engineering division of the U. S. Bureau of Reclamation.

CHARLES GILMAN HYDE, professor of sanitary engineering at the University of California, has been appointed consulting engineer of the San Francisco department of public health.

HARRY P. NICHOLS announces that he has severed his connection with the American Abrasive Metals Co., New York, and has opened an office in New York City as consulting engineer, specializing in municipal franchises, contracts and negotiations.

OSCAR KIBELE, contractor, of Columbus, Ohio, has been appointed head of the department of building regulation of the city, to fill the vacancy caused by the resignation of Bert Walter, who held the position for eight years.

Obituary

ARTHUR PEW, consulting engineer, of Atlanta, Ga., died on Dec. 26. Early in his engineering career Mr. Pew served as assistant engineer and chief engineer on location and construction of various railroads in the South and since 1898 had been in private consulting practice, first in Bainbridge, Ga., and later in Atlanta. He designed and constructed municipal improvements in many cities in Georgia, Alabama and Florida. He was a member of the American Society of Civil Engineers and in 1911 was president of the Engineering Association of the South in Nashville, Tenn.

WILLIAM D. POMEROY, vice-president and general manager of Goulds Pumps, Inc., ended his life in Seneca Falls, N. Y., on Jan. 6 by shooting himself in the head. Mr. Pomeroy was a graduate of the engineering school of Cornell University and had been with the Goulds firm since 1907.

R. S. STEVENS, of Asheville, N. C., highway contractor who had built many miles of concrete roads in the southeastern section of the country, died suddenly on Jan. 5. At one time Mr. Stevens was president of the Carolinas branch of the Associated General Contractors.

JAMES OWEN, senior assistant engineer of the Westchester County (N. Y.) Park Commission, died on Jan. 10. Before joining the Westchester commission nine years ago, Mr. Owen was an assistant engineer in the New York City department of gas, water and electricity and in the Bronx Parkway Commission.

HENRY T. PORTER, who retired as chief engineer of the Bessemer & Lake Erie Railroad last April, died on Jan. 11 at his home in Greenville, Pa. He was 63 years old.

SOCIETY CALENDAR

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; annual meeting, Jan. 19-22, New York City.

AMERICAN WOOD PRESERVERS' ASSOCIATION, Chicago; annual meeting, St. Louis, Jan. 26-29.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; thirteenth annual convention, Jan. 18-21, Milwaukee, Wis.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; fifteenth annual convention and exposition of quarry equipment and machinery and supplies, Pittsburgh, Pa., Jan. 19-22.

NATIONAL PAVING BRICK ASSOCIATION, Washington; annual meeting, Chicago, Feb. 10-12.

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington; annual meeting, Pittsburgh, Jan. 27-29.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold a joint meeting in New York City on Feb. 18 with the Iron and Steel Division, Institute of Metals Division and New York Section of the American Institute of Mining and Metallurgical Engineers. F. O. Clements, president, A.S.T.M., and technical director, General Motors Research Laboratories, will speak on "Limits of Our Knowledge of the Properties of Metals," and H. F. Moore, past-president, A.S.T.M., and research professor of engineering materials, University of Illinois, will address the meeting on "Test Results and Service Values of Metals." A demonstration of ten different tests of welds will be given by A. B. Kinzel and W. B. Miller, Union Carbide & Carbon Research Laboratories, Inc., and John J. Crowe, Air Reduction Laboratories, Inc. The meeting will begin at 8 o'clock and all interested are invited to attend.

HALIFAX BRANCH, Engineering Institute of Canada, at its annual meeting elected A. F. Dyer president and reelected R. R. Murray secretary. One of the subjects for discussion at the annual meeting of the engineering branch was that of the advisability of merging the engineering organizations of Canada into one body. No decision was reached.

MONTREAL BRANCH, Engineering Institute of Canada, at its fourteenth annual meeting elected the following officers: chairman, P. E. Jarman, city manager, Westmount, Que.; vice-chairman, E. A. Ryan.

NASHVILLE ENGINEERING ASSOCIATION has elected the following officers for 1932: president, J. M. Farrar; vice-president, E. W. Bauman; treasurer, L. O. Hopkins.

ROCHESTER SECTION, American Society of Civil Engineers, at its annual meeting on Jan. 7 elected officers as follows: president, Robert B. Jeffers; vice-presidents, Henry L. Howe and Carl C. Coonan; secretary-treasurer, Charles F. Starr.

SEATTLE SECTION, American Society of Civil Engineers, has elected O. A. Piper, chief assistant city engineer, president. M. O. Syliaasen has been elected vice-president and T. D. Hunt reelected secretary-treasurer.

SOUTH CAROLINA SOCIETY OF ENGINEERS at its third annual winter conference in Columbia elected the following officers: president, J. E. Gibson, Charleston; vice-president, John A. McPherson, Greenville; secretary-treasurer, Robert L. Sumwalt, Columbia.

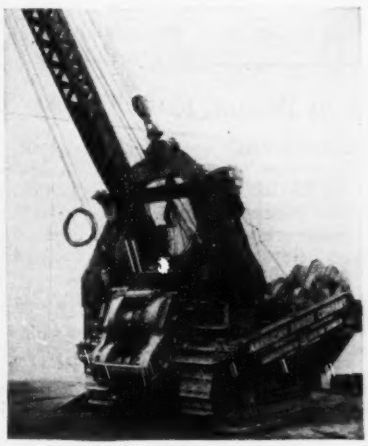
Construction Equipment and Materials

Hoist-Equipped Tractor Basis of New Line of Equipment

AN INTERESTING new line of erection equipment has been announced by American Hoist & Derrick Co., St. Paul, Minn., in which the central units are a derrick-equipped crawler tractor and a steel trailer wagon. The manufacturer points out that various combinations of these two units with auxiliary equipment enable the erector to meet the requirements of a wide variety of jobs, including both light- and heavy-duty mobile hoisting, steel erecting, all-around tractor work, pipe-line construction, oilfield operations, logging, dragline and bucket work, unloading, handling, distributing and car switching.

The basic unit is the crawler tractor. Either a Caterpillar 60 or an Allis-Chalmers Model L Monarch may be used. In Combination 1, shown in Fig. 1, a special industrial-type, double-drum hoist with large lead-line pull is mounted over the forward part of the tractor, and on one side at the rear is mounted a shelf hoist with four drums having sufficient wire rope capacity to operate a complete derrick, including the swing lines. Combination 1 takes the place of any kind of power hoist and has the added advantage of being able to run anywhere under its own power. Its two main drums furnish topping lift and main falls for a derrick and the four auxiliary drums of the shelf hoist furnish wire rope swing-lines and runner-line. The whole combination is operated by one man.

Fig. 1 (above)—Crawler tractor with complete hoisting equipment.
Fig. 2 (below)—Tractor-derrick of 6-ton capacity.



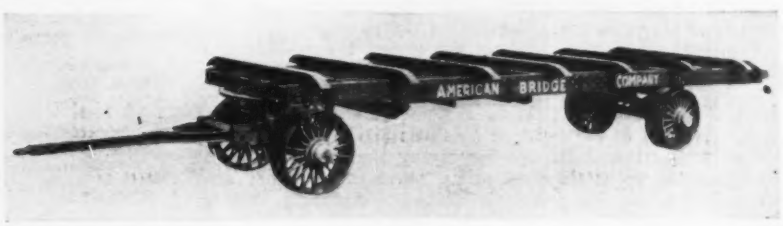
In Combination 2 a double-drum hoist, with two wire rope niggerheads on a jack shaft that can be used either for runner-lines or for swinging a boom, is placed on a special skid-frame either in front of the tractor or beside it, and is driven by a chain from the power take-off shaft on the tractor power unit of Combination 1. This Combination 2 is used for large hoisting operations where a number of wire rope runner-lines are needed. The large drums on the auxiliary hoist will hold 3,500 ft. of ¾-in. wire rope. It is especially adapted to the erection of heavy bridgework or for heavy derrick-boat operation. This unit is centrally operated by one man. Combination 2 is stationary, while Combination 1 is mobile. Installations similar to Combination 2, placed in barges, were utilized to operate guy derricks in erecting several recent cantilever bridges, notably at Rochester, Pa., at Louisville, Ky., and at Evansville, Ind.

Combination 3, shown in Fig. 2, consists of Combination 1, to which is added a derrick with a boom that swings through 180 deg. This provides a complete rig for unloading, erecting and handling construction materials. With 2 tons of counterweight placed in front of the radiator and with a 30-ft. boom, this tractor-derrick has a maximum capacity of 6 tons when fully blocked and with the boom 10 ft. to the front. The capacity is 3 tons with or without blocking and the boom at 20 ft. Three tons is also the capacity when the rig is required to move with a load. One ton can be lifted 18 ft. to the side with the boom set at 20-ft. reach and no blocking under the outfit. With a 12-ft. curved boom extension, 800 lb. can be handled up to 30-ft. reach at any angle without blocking the tractor.

The steel trailer wagon, shown in Fig. 3, 30 ft. long center to center of trucks, was designed especially for unloading and distributing structural steel. Transverse I-beams spaced about 4 ft. apart comprise the deck of the wagon, the top flanges of these I-beams being bent down at either end to permit sliding off the steel when unloading. The wagon is available either with wide-tire steel wheels or crawler treads and is so designed that the body may be removed, making available two separate trucks which may be spread apart any distance to accommodate long pieces such as girders and roof trusses.

In Combination 4, Combination 1 is mounted on the rear of the trailer-wagon, while the front end of the wagon is equipped with an A-frame and a long boom. Thus a completely equipped derrick car is provided, suitable for use on large work where a long boom and heavy-handling capacity are required. The tractor furnishes the power for hoisting and propelling, provision being made for driving the rig through the rear trucks and steering it through the front trucks. It is pointed out that Combination 4 can take the place of the ordinary crawler crane and has the added advantage that its component parts can be used for numerous different operations and that its maximum lifting capacity can be handled on a perfectly flat boom, whereas in a crawler crane this maximum load can only be handled a few feet away from the center of revolution. The derrick placed on this wagon is made in three capacities: 7, 15 and 30 tons, respectively, on a 60-ft. boom flat.

Fig. 3—Steel trailer wagon used for hauling or as chassis of derrick car.



Business Notes

LOCK JOINT PIPE CO. has announced an arrangement with the American Concrete & Steel Pipe Co., of Los Angeles, whereby the American Company will manufacture and install Lock Joint steel-cylinder-reinforced concrete pipe west of the Rocky Mountains and in Texas.

JOY MANUFACTURING CO., Franklin, Pa., announces a settlement of patent litigation against the Herzler & Henninger Machine Works of Belleville, Ill. Under the terms of the settlement the continued use of Wilson loaders purchased from Herzler & Henninger is granted and repair parts will be available, but the machines cannot be rebuilt or resold.

J. FREDERIC WIESE, who has been assistant to the general manager of sales of LUKENS STEEL CO., Coatesville, Pa., has been appointed assistant to F. H. Gordon, vice-president in charge of sales. Mr. Wiese will maintain headquarters at Coatesville.

STANLEY TOOLS, New Britain, Conn., announces the purchase of the rule business of Hiram A. Farrand, Inc., of Berlin, N. H.

SMITH TRACTOR & EQUIPMENT CO., formerly the E. & F. Smith Co. of New York, has been appointed dealer for the Caterpillar Tractor Co., Peoria, Ill., for the northern New Jersey territory. Headquarters have been opened at 212 Coit St., Irvington, N. J.

LAMB TRACTOR CO., a $400,000 corporation, has been organized at Hoquiam, Wash., to manufacture a new type tractor for logging and road grading.

WILLIAM E. UMSTATTD has been made executive vice-president of the TIMKEN ROLLER BEARING CO., Canton, Ohio. Mr. Umstattd has been with the Timken organization for thirteen years, during the last two years of which he has occupied the position of factory manager.

NATIONAL STEEL FABRIC CO., Pittsburgh, announces the appointment of C. B. Dugan as district manager of the Los Angeles office, Richfield Bldg., and H. M. Wilson as district manager of the Chicago office, Strauss Bldg.

HAROLD BROOKS GARDNER, Eastern district manager of the Westinghouse Air Brake Co., with headquarters in New York, died at his home in New Rochelle, N. Y., Jan. 2 after a brief illness.

THOMAS P. KINGSFORD, 73, head of the Kingsford Foundry & Machine Works, Oswego, N. Y., died at Oswego Jan. 5.

Current Construction Unit Prices

Dredging San Joaquin River, Calif.

SAN JOAQUIN RIVER is being dredged for a distance of 1.9 miles downstream from Burns Cut-Off to El Dorado Pump on Robert's Island. The upstream end of the work is 3.5 miles from Stockton, Calif. The present river channel, which is to be deepened, widened and straightened, is 200 to 300 ft. wide and 10 to 15 ft. deep. The new channel will be 100 and 110 ft. wide and 26 ft. deep at mean lower low water. Materials consist of 1,289,000 cu.yd. of peat, loam, sand and clay. Distance to spoil area averages 2,000 ft., maximum 4,000 ft. The ordinary tide range is 3 ft. in the low-water season, with maximum range of 12 ft. from low to flood.

Unit prices are given below of the four bidders: (A) Hydraulic Dredging Co., Oakland, contract; (B) San Francisco Bridge Co., San Francisco; (C) Standard Dredging Co., Oakland; (D) Longview Dredging & Construction Co., Longview. Work is under supervision of the U. S. Engineer office, Sacramento.

	A	B	C	D
Per cubic yard	$0.1238	$0.125	$0.1294	$0.14
Approximate total	$159,578	$161,125	$166,797	$180,460
Plant to be used:				
Kind	Hydraulic	Suction	Hydraulic	Suction
Capacity	30-in.	20-in.	24-in.	24-in.
Guarantee, bid bond	$25,000	$18,500	$19,000	$18,000

Dredging in Delaware River

A CHANNEL 11.6 miles long is being dredged in the Delaware River from Delanco to Roebling, N. J. Depth is 20 ft. at mean low water, width 200 ft. Accompanying bids cover 620,000 cu.yd. mud, sand, clay, gravel, cobbles and boulders. Average distance of disposal is 2,000 ft. Mean bid range is 5 ft., and maximum current 1.8 miles per hour.

	Unit Price	Amount	Rate per Month, Cu.Yd.
Trimount Dredging Co., 10 State St., Boston	$0.339	$210,180	77,500
American Dredging Co., 308 Chestnut St., Philadelphia	.375	232,500	62,000
Standard Dredging Co., 2701 Woolworth Bldg., New York	.39	241,800	300,000
Atlantic, Gulf & Pacific Co., 15 Park Row, New York	.4289	265,918	300,000
Central Dredging Co., 307 N. Michigan Ave., Chicago	.46	285,200	Not stated
W. H. Gahagan, Inc., 147 Remsen St., Brooklyn	.57	353,400	100,000

Trunk Sewer, Pumping and Treatment Plant for Princeton, N. J.

SEWER WORK worth $521,724 was placed under contract in October, 1931, at Princeton, N. J. Thirty-four contractors submitted 60 bids.

Work was let in three contracts. Contract A is for the treatment plant and pumping station. The station is a one-story brick and concrete building 27x47 ft. over a concrete pump pit and suction well. Three pumps lift sewage 67 ft. through 1,800 ft. of 18-in. cast-iron pipe for treatment. The plant is of the sprinkling filter type and will handle 2,000,000 gal. per day. Equipment includes two concrete, hopper-bottom, primary sedimentation tanks; two concrete dosing tanks; one sprinkling filter, 8-ft. depth; one secondary sedimentation tank; two covered sludge-digestion tanks of four compartments each, and chlorinating equipment.

Principal prices are given of the lowest three bidders on the pumping and treatment plant: (A) Engstrom & Wynn, Inc., Wheeling, W. Va., contract; (B) Merritt-Chapman & Scott, New York; (C) Wm. Eisenberg & Sons, Camden, N. J. Average of the eighteen bids was $263,000.

Contracts B1 and B2 are for laying the two sections of the trunk sewer totaling 13 miles, more than 85 per cent being through private property. Separate contracts were let on the two sections. Bids were also received on the entire sewer. Pipe consists of 18,684 ft. 10- to 18-in. vitrified laid 0-10 ft. deep; 28,970 ft. 24- to 36-in. reinforced-concrete laid 0-14 ft. deep. Unit prices of the lowest three bidders are given for the concrete pipe items. Contracts were awarded to Vincenzo DiFrancesco, Llanerch, Pa., for $118,247 for Sec. B1, and to Castone Bros., Inc., Montclair, N. J., for $115,102, for Sec. B2.

Contract C is for furnishing the 24 to 36-in. reinforced-concrete pipe. Unit prices are given of the lowest three bidders, all of New Jersey: (A) Lock Joint Pipe Co., Ampere, contract; (B) Newark Concrete Pipe Co., Newark; (C) J. L. Sigretto, Carlstadt.

This project has no particularly difficult features. Earth is mainly sand, except on some portions of the sewer; rock is red shale and sandstone. Design and construction are under the supervision of Nicholas S. Hill, Jr., New York; I. R. Riker is resident engineer.

CONTRACT A, TREATMENT PLANT

	A	B	C
13,000 cu.yd. earth excav.	$0.50	$0.85	$0.40
11,300 cu.yd. embankment	.30	.18	.20
2,500 sq.yd. roadways	1.00	1.25	.60
3,400 cu.yd. A conc. 1 : 2 : 4	20.70	17.50	17.42
300 cu.yd. B conc. 1 : 3 : 6	6.00	7.60	9.00
10,000 lb. reinforcement	.04	.054	.05
11,700 cu.yd. stone fill in filter	2.40	2.00	2.65
Alternate, slag	3.10	2.10	3.40
Furnish and lay outside, 13,000 ft. 4- and 8-in. vit.	.30	.31	.36
Furnish and lay outside, 750 ft. 18-in. vit.	1.40	1.20	1.30
Lay 400 ft. 24-in. conc.	1.00	.62	1.40
Lay 400 ft. 30-in. conc.	1.40	.73	1.50
Furnish and Lay C. I. Pipe:			
1,300 ft. 3- and 4-in.	.75	.63	.75
1,600 ft. 6- and 8-in.	1.75	1.35	1.85
170 ft. 16-in.	4.50	4.60	4.70
2,300 ft. 18-in.	3.15	3.12	4.00
Chlorine equip.	4,600.00	5,834.00	4,500.00
Inside piping	10,000.00	11,068.00	11,100.00
Dist. and drain for filter	12,000.00	13,305.00	12,233.00
Dosing tank and equip.	7,000.00	8,221.00	6,600.00
Glass covers for sludge beds	8,500.00	13,200.00	12,500.00
Sludgebed underdrains	250.00	462.00	300.00
Sludgebed filter material	1,600.00	1,659.00	2,000.00
Water-supply system	10,000.00	10,000.00	10,000.00
Pumping machinery	10,000.00	11,093.00	10,600.00
Electric light and power equipment	9,500.00	11,589.00	10,500.00
Total	$233,650.00	$243,243.00	$246,121.00

CONTS. B1 AND B2, EXCAVATE, BACKFILL, HAUL AND LAY PIPE
(Low Bidders on Whole Sections)

	Secta. B1 and B2 Combined		Average for Secta. Bid Separately	
Concrete Pipe Items:	Lowest	Average Low 3	Lowest on Each Averaged	Lowest 3 on Each Averaged
2,850 ft. 36-in., 0 to 16 ft.	$3.32	$4.34	$5.91	$4.95
9,090 ft. 30-in., 0 to 12 ft.	2.34	2.22	2.18	2.66
27,030 ft. 24-in., 0 to 14 ft.	1.68	1.91	1.54	1.60

CONT. C, FURNISHING REINFORCED-CONCRETE SEWER PIPE

	A	B	C
3,100 ft. 36-in.	$2.50	$2.52	$2.550
9,500 ft. 30-in.	1.64	1.76	1.836
27,300 ft. 24-in.	1.15	1.23	1.275
Total	$54,725.00	$58,111.00	$60,154.50

Sewer at Bristol, R. I.

CONTRACT for an intercepting sewer for Bristol, R. I., was awarded in December, 1931, to the Callan Construction Co., Bristol, for $36,932. H. K. Barrows, Boston, is consulting engineer. Alternate bids were asked on vitrified and reinforced-concrete pipe; lowest four unit prices on these items are given below:

Vitrified:	A	B	C*	D
2,700 ft. 18-in.	$2.50	$2.52	no bid	$2.25
1,735 ft. 21-in.	3.74	3.00	no bid	2.25
960 ft. 24-in.	5.63	3.85	no bid	2.25
Reinforced-Concrete:				
2,700 ft. 18-in.	2.50	2.00	$1.60*	2.50
1,735 ft. 21-in.	2.70	2.25	1.80*	2.50
960 ft. 24-in.	3.35	3.20	2.70*	3.00

*Callan bids.